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**TAXONOMIC STUDIES ON THE FAMILY  
LYTHRACEAE IN INDIA**

THESIS SUBMITTED TO THE UNIVERSITY OF  
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DOCTOR OF PHILOSOPHY IN SCIENCE (BOTANY)

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#### DECLARATION

I hereby declare that the thesis entitled **TAXONOMIC STUDIES ON THE FAMILY LYTHRACEAE IN INDIA** is a bonafide record of research work and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Calcutta,  
1-3-1993.

  
**THOMAS MATHEW, P.**

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## INTRODUCTION

The family Lythraceae Jaume St. - Hilaire, <sup>R</sup>Sensu <sup>P</sup>Stricto, named after the genus Lythrum, and commonly known as the Loosestrife family, comprise<sup>S</sup> 28 genera and about 600 species (Graham et al., 1985) chiefly distributed in the warmer parts of both the Old and New Worlds. The family includes several economically important plants (ornamental and dye-and timber-yielding plants). The plants are herbs, shrubs and trees with mostly opposite, simple, entire leaves, often having showy flowers which are 3-6 merous; and are characterised generally by a combination of characters like crumpled petals, mostly diplo- or haplostemonous androecium, stamens attached inside and near the base of the hypanthium, and superior ovary free inside the hypanthium. The fruits are capsular, septicidally<sup>ly</sup> dehiscent or indehiscent.

Taxonomic study of plants of the family as a group was started by Linnaeus in 1753; and he described them under the 'class' Tetrandria monogynia, Dodecandria monogynia, Icosandria monogynia, etc. Subsequently, detailed classificatory treatment<sup>S</sup> of the family have been made by several taxonomists; and there exists<sup>a</sup> great deal of disagreement among them concerning the placement, composition and systematic relationships and affinities.

Bentham and Hooker (1862), Takhtajan (1966, 1969), Cronquist (1968), Dahlgren (1975, 1980) and Dahlgren and Thorne (1984) have placed the Lythraceae under the order Myrtales, Engler and Prantl (1936) in their order Myrtifloreae, while Hutchinson (1926, 1959) and Briggs and Johnson (1979) have kept it under the order Lythrales. According to Dahlgren and Thorne (1984) and Johnson and Briggs (1984), the Lythraceae occupy a key (basal) phylogenetic position within the Myrtales.

Bentham and Hooker (1862) considered the genera Punica, Axinandra, Crypteronia, Sonneratia and Duabanga as members of Lythraceae, while Koehne (1903) <sup>was</sup> of the view that the genera Punica, Axinandra, Crypteronia, Sonneratia and Duabanga <sup>were</sup> as members of distinct families. Two recent classifications (Cronquist, 1981; Takhtajan, 1980, 1986) maintain Punicaceae (Punica) and Sonneratiaceae (Duabanga, Sonneratia) as separate families, but Thorne (in Dahlgren and Thorne, 1984) treats them as subfamilies of the Lythraceae.

C.B. Clarke's work in Hooker's (1879) Flora of British India is the only comprehensive contribution on the taxonomy of the Indian members of the family; and since this, there have been several additions of new taxa and also separation

of a few genera from the family. As a result of recent plant explorations in India in areas previously inaccessible, <sup>9</sup>several additional data on the distributional, ecological and phenological ranges of the family have been acquired. However, our current knowledge on the taxonomy of the Indian members of the family is still inadequate and incomplete, and hence the present work was undertaken primarily with a view to studying the Indian species in respect of their taxonomic status, patterns of distribution, alliances, endemism, nomenclature, synonymy and genetic resources. The work chiefly envisages

*Not really a revision, more floristic than revisionary?*

1. (revision of the Lythraceae) *sensu stricto* based on taxonomic studies, and
2. study of seed morphology aided by Scanning Electron Microscope so as to facilitate identification at microlevel.

**TAXONOMIC STUDIES ON THE FAMILY LYTHRACEAE IN INDIA**

**CHAPTER I**

**TAXONOMIC STUDIES**

#### A. LITERATURE REVIEW OF THE FAMILY LYTHRACEAE

The earliest scientific literature describing Indian plants of family Lythraceae is credited to Rheede (1678-1703) followed by Burman (1737) and Rumphius (1741-50), contributing to the Pre-Linnean literature which formed the basis of "species plantarum" (Linnaeus, 1753). Study of the family Lythraceae as a group was begun by Linnaeus in 1753 and later publications under the 'classis' Tetrandria monogynia, Dodecandria monogynia, Icosandria monogynia, etc. He recognised the following five genera Rotala, Ammannia, Lythrum, Lawsonia and Lagerstroemia, occurring in India. It was Jussieu in 1791, who first proposed this group as a family under the name Salicariae. He divided the family into two groups: (1) Flores polypetali - in which Lagerstroemia, Munchausia, Pemphis, Ginoria, Lawsonia, Crenea, Lythrum, Acisanthera, Parsonsia, Cuphea and Grislea are included and (2) Flores apetali - in which Isnardia, Ammannia, Glaux and Peplis are included. Jaume St. - Hilaire (1805) gave the present name Lythraceae (as "Lythraridae") based on the genus Lythrum, and <sup>it</sup> is conserved over the earlier name Salicariae. De Candolle's description of Lythraceae in 'Prodromus Systematis Naturalis Regni Vegetabilis' (De Candolle, 1828) was the first major account of this family on a global basis. He recognised 26 genera and 178 species. Bentham and Hooker f. (1867) recognised two tribes and 30 genera for the family. The

tribe Ammannieae <sup>include</sup> ~~is with~~ five genera, and Lythreae, contains 22 genera. The four genera viz. Punica, Axinandra, Olinia and Heteropyxis were treated as anomalous genera, being unique in the family having inferior ovary. The tribes were characterised as: low or aquatic herbs; calyx membranous, without any ribs and wings; flowers small or minute - Ammannieae, and trees or shrubs; calyx herbaceous or coriaceous, multiribbed or winged; flowers large - Lythreae. Koehne (1903) monographed the family and recognised two tribes and 22 genera. The tribes were segregated on the basis of septa of the ovary being interrupted or complete. In tribe Lythreae the septa are interrupted or split above the placenta, which is then discontinuous with the style; in Nesaeae Koehne, the septa are complete and the placenta is continuous with the style. He considered the genera Punica, Crypteronia, Sonneratia, Duabanga and Axinandra as members of distinct families. *Most recent studies conclude that the character is not accurately described and, in fact, all members of the family have septa incomplete to some degree. The tribes are considered artificial*

Roxburgh (1820) in his 'Flora Indica' while dealing with the Lythraceae of British India, described 13 species under five genera belonging to the classis, Tetrandria monogynia, Dodecandria monogynia, Icosandria monogynia, Octandria monogynia, etc. Wight and Arnott (1834) in 'Prodromus Florae Peninsulae Indiae Orientalis' considered eight genera and 24 species. Wight (1840-1853) illustrated 12 species of this family in his 'Icones Plantarum Indiae



Orientalis'. Again in his 'Illustration of Indian Botany' (1840) he discussed critically the affinities. The first revision of the family Lythraceae for the Indian region was done by Clarke (1879) in Hooker's 'Flora of British India', and he considered 11 genera and 45 species. He divided the family into two tribes based on Bentham and Hooker's (1867) treatment. This critical revision of Indian Lythraceae summarised the results of the collections made by Roxburgh, Wallich, Wight and Arnott, Griffith, Thwaites, Kurz, Hooker f. and others. He included the peripheral families such as the Crypteroniaceae, Sonneratiaceae and Punicaceae under the Lythraceae.

Cooke (1901) in the 'Flora of the Presidency of Bombay' described five genera and 18 species. Prain (1903) in 'Bengal Plants' gave an account of the Lythraceae consisting of five genera and 19 species. Duthie (1903) in the 'Flora of Upper Gangetic Plain' gave an account of the Lythraceae consisting of four genera and 12 species. Gamble (1919) in the 'Flora of the Presidency of Madras' recognised seven genera and 22 species for the family in South India. Haines (1921) in his 'Botany of Bihar and Orissa' reported five genera and 17 species from that area. Kanjilal et al. (1934) in 'Flora of Assam' recorded five species in three genera under the family Lythraceae.

During the same period a number of Floras of adjoining countries were published such as the works of Kurz (1977) on the 'Forest Flora of British Burma', Trimen (1893) on the 'Flora of Ceylon', Ridley (1922) on the 'Flora of Malayan Peninsula', Merrill (1923) 'Enumeration of the Philippine Flowering Plants and Flora of Manila'. Iqbal Dar (1979) in the 'Flora West Pakistan' considered five genera and 13 species. Hara and Williams (1979) in their 'Enumeration of the Flowering Plants of Nepal' recorded five genera and 14 species. Lee and Lau (1983) in Lythraceae, Fl. Reipubl. Pop. Sinicae considered 44 species of 10 genera for China.

Blatter and Hallberg (1918) revised the genera Rotala, Ammannia and Nesaea of British India. Furtado and Srisuko (1969) revised the genus Lagerstroemia for the world. <sup>Speller</sup> Leuwan (1971) revised the genus Rotala for Malesia. He recognised four species for Malaysia of which all are present in India. Cook (1979) revised the genus Rotala for the world, and recognised 44 species of which 19 are present in India. Graham (1979) revised Ammannia for South Eastern United States. She considered five species of which two are present in India. Joseph and Sivarajan (1989) published an account of the genus Rotala in the peninsular India. They recorded 16 species for peninsular India of which two were proposed as new species.

## B. GENERAL CHARACTERS OF LYTHRACEAE

The family Lythraceae consisting of about 27 genera and about 600 species form a natural and well defined group exhibiting a number of common features. In habit, they range from herbs to fairly large trees. The leaves are opposite, rarely alternate or whorled, petiolate or sessile, entire, estipulate. The stems and leaves are usually glabrous, rarely pubescent or glaucous. The flowers are solitary and axillary or in terminal or axillary racemes, spikes or panicles; actinomorphic or zygomorphic, bisexual, bracteate, (-3) 4-6 merous, sometimes dimorphic and trimorphic. The calyx is united to form a tube, generally called as ~~as~~ hypanthium. Calyx tube campanulate, urceolate or cylindrical, with 3-6 lobes, often with appendages alternating with them. Corolla is large and showy to minute or absent, crumpled. Petals are 0-6 in number, free, inserted on the side of the calyx tube between the lobes, and the petal colours are mainly pink, red, purple and white. The stamens are as many as the petals or numerous. Filaments<sup>are</sup> usually unequal in length. Anthers are dithecous, dorsifixed, dehiscing longitudinally. The ovary is superior, free in the calyx tube, 2-6 locular, the septa complete or incomplete. Ovules are numerous in each locule,

placentation axile. Styles are usually single or obsolete. Stigmas are capitate, <sup>punctiform,</sup> rarely bilobed. The fruits are capsular, septicidally or loculicidally dehiscent or irregularly dehiscent or indehiscent, 3 to many seeded. The seeds are pyramidal, ovoid or discoid in shape, sometimes winged, glabrous, with little or no endosperm.

Pollen is tricolporate (some heterocolpate with either 3 or 6 subsidiary colpi), radially symmetrical, and isopolar. Great variability exists in shape, surface sculpture, aperture system and to lesser extent, exine structure. Shape in lateral view : oblate-suboblate, spheroidal-subprolate or spheroidal; in polar view: triangular-geniotreme, triangular-pleurotreme, triangular to hexagonal or circular. The apertures are tricolpoidorate, tricolporate, tricolporate-syncolpate or porate. Subsidiary colpi (pseudocolpi) 0-3-6. Surface sculpturing is striate, psilate, verrucate and granular (Patel et al., 1984).

<sup>the</sup> Embryo is straight with a short radicle, cotyledons flat, often auriculate-cordate. Embryo sac development of the normal (Polygonum) type; endosperm development of the nuclear type (Joshi, 1989). A uniseriate or, less commonly, a multiseriate suspensor is present in the

embryo. The archesporium is multicellular (Joshi and Venkateswarlu, 1936)

Baas and Zweypfenning (1979) have studied the wood anatomy of Lythraceae; the salient features are: "scantly paratracheal parenchyma, heterogeneous uniseriate and multiseriate rays, (septate) libriform fibres with minutely bordered pits, and vessels with simple perforations. Specialisation has been limited in most Lythraceae of shrubby or herbaceous habit; these have juvenilistic rays composed mainly of erect rays and sometimes completely lack axial parenchyma. Ray specialisation towards predominantly uniseriate homogeneous rays, concomitant with fibre dimorphism leading to abundant parenchyma differentiation, and with the advent of chambered crystalliferous fibres has been traced in the genera Génoria, Pehria, Lawsonia, Physocalymma, and Lagerstroemia. The genus Lagerstroemia has the most specialised wood anatomy in the family and has species with abundant parenchyma as well as species with alternating bands of dimorphic septate fibres. Pemphis represents an independant specialisation with its vasicentric parenchyma and thick-walled non septate fibres".

### C. GEOGRAPHICAL DISTRIBUTION

The family is well represented all over the world, occurring mainly in the tropics and subtropics and occasionally in the temperate regions.

The ancestral forms of the family are Eocene in age, and are found as members of warm-temperate vegetation characterizing the Indo-Malayan region of the Old World tropics. According to Graham and Graham (1971) "the oldest known occurrence of definite Lythraceae megafossils is in the lower Eocene London Clay Flora of South-eastern England and middle Eocene deposits from a number of localities in the same region and the Eocene Deccan Intertrappean beds of India. During the time these floras were deposited, north-western Europe was characterised by biotas associated with either a northern cold sea or the warm southern Tethys sea, the latter connected through the mediterranean with the Indian ocean. Thus the floras that developed around the Southern sea were lower to middle tertiary tropical to subtropical communities having affinities with the present day Indo-Malayan vegetation".

Nine genera are known from lower Tertiary Floras of England, and three others have been described from the

Deccan flora. Sahni (1943) reported silicified fruits of Enigmocarpon parijai from the Deccan Intertrappean series in the Chhindwara district of India. Flowers associated with Enigmocarpon were subsequently described as a new genus Sahnianthus (Shukla, 1944). Both of these genera were considered related to the living genus, Decodon. Puri (1943) has reported Woodfordia fruticosa (L.) Kurz, from a Pleistocene flora on Kashmir. Leaf impressions referred to Lagerstroemia indica <sup>have been reported</sup> were known from the Mohgaon, Kalan and Bharatwada localities of the Deccan Intertrappean flora (Shukla, 1950).

The megafossil evidence indicates that the Lythraceae was differentiated as a distinct family by the beginning of the Eocene and probably had its origin in the Indo-Malayan region of the old world tropics. A total of 18 genera have been recognised in geologic strata ranging in age from lower Eocene to recent, and among the 27 modern genera seven have a documented geologic history. The first genus to differentiate into a form comparable to a modern member of the family, and thus the oldest of extant <sup>a</sup> genera presently recorded is Lagerstroemia. Its early development or differentiation is consistent with its recognised primitive position in the family. Among genera for which an adequate fossil record is available, Cuphea is the most recently

*the 1st modern genus to be recognized among known fossils - not necessarily the 1st to differentiate we don't know that because the fossil record is very incomplete*

developed or differentiated genus, and is recognised as the most advanced member of Lythraceae. <sup>(ref?)</sup> Its fossil record and modern distribution confine it to the New World.

Out of the 28 genera and about 600 species in the world, India has only eight genera and 42 species. The genus Cuphea of New World origin has been introduced to India as an ornamental. All the genera occurring in India have a wide distribution.

Some of the arborescent species of the family in India such as Lagerstroemia speciosa and L. parviflora occur in the forests throughout India, while L. microcarpa, L. minuticarpa and L. hypoleuca are restricted to Western Ghats, Assam forests and Andaman and Nicobar Islands respectively. Pemphis acidula is unique in <sup>preferring</sup> ~~having~~ its ~~preference~~ to salt water habitat; it grows <sup>along</sup> in southern coasts and <sup>the</sup> Andaman islands.

Besides these arborescent species the rest of the Indian Lythraceae are herbs, under shrubs or shrubs. These groups of plants are widely distributed from sea level to ~~the~~ temperate zone, waste lands, jungles, paddy fields and marshy areas. Species of the genus Lythrum occur in temperate regions of India, in Himachal Pradesh and Kashmir.



The species like Ammannia baccifera, A. multiflora, Rotala densiflora, R. indica, etc. grow in paddy fields, and other moist places throughout India. Lawsonia, a monotypic genus grows as a hedge plant in the plains throughout India. Woodfordia fruticosa occurs in jungles and forests all over India except extreme south.

In India, there <sup>are</sup> ~~is~~ no endemic genus <sup>es</sup> of Lythraceae, but some species are endemic to India and a few are restricted to India and adjoining countries. The endemic species (with their known places of occurrence given against each) are as follows.

1. Rotala floribunda (Wight) Koehne - Maharashtra
2. Rotala macrandra Koehne - Maharashtra, Karnataka,  
Tamil Nadu and Kerala
3. Rotala ritchiei (Clarke) Koehne - Maharashtra, Tamil Nadu  
and Karnataka
4. R. illecebroides Arn. Ex Koehne - Madhya Pradesh, Andhra  
Pradesh, Tamil Nadu and  
Karnataka
5. Rotala fimbriata Wight - Andhra Pradesh, Tamil Nadu and  
Karnataka
6. Rotala malampuzhensis R.V.Nair ex C.D.K.Cook-Maharashtra,  
Karnataka  
and Kerala.

7. Rotala cookii Joseph et Sivar. - Kerala
8. Ammannia nagpurensis Mathew et Nayar - Gujarat and Maharashtra.
9. Lagerstroemia microcarpa Wight - Maharashtra, Tamil Nadu, Karnataka and Kerala.
10. Lagerstroemia minuticarpa Debber. ex Kanjilal - Assam and Sikkim.
11. Lagerstroemia hypoleuca Kurz - Andaman & Nicobar Islands.

The species which occur in India and adjacent countries are:

1. Rotala verticillaris L.- India, Eastern coast from West Bengal to Tamil Nadu and Sri Lanka.
2. Rotala serpyllifolia (Roth) Bremek. - Central and North West India and Pakistan.
3. Rotala simpliciuscula (Kurz) Koehne - Meghalaya (North east India) and Bangladesh.
4. Rotala rubra (Buch.- Ham. ex. D.Don) Hara - West Bengal (India) and Nepal.
5. Ammannia desertorum Blatter & Hallb.- Rajasthan, Gujarat (India) and Pakistan.

#### D. MATERIALS AND METHODS

All the published names in this group from the area of study and adjacent regions were indexed and protologues were gathered from various libraries and herbaria.

Herbarium materials from the following herbaria were studied either by procuring on loan or by visiting them.

ASSAM	-	Kanjilal Herbarium, Botanical Survey of India, Eastern Circle, Shillong.
BLAT	-	Blatter Herbarium, St. Xavier's College, Bombay.
BSD	-	Botanical Survey of India, Northern Circle, Dehra Dun.
BSI	-	Botanical Survey of India, Western Circle, Pune.
BSIM	-	Botanical Survey of India, Industrial Section, Indian Museum, Calcutta.
BSJO	-	Botanical Survey of India, Aridzone Circle, Jodhpur.
CAL	-	Central National Herbarium, Botanical Survey of India, Howrah.
CALI	-	Calicut University Herbarium, Department of Botany, University of Calicut.
DD	-	Forest Research Institute, Dehra Dun.
MH	-	Madras Herbarium, Botanical Survey of India, Southern Circle, Coimbatore.

The specimens were collected with care in the field. A portion of the material was pickled using 50 per cent alcohol and 5 per cent glycerin or 50 per cent alcohol. Alcohol content was increased to 55 per cent in the case of aquatic plants. As the material never becomes brittle this process facilitates easy dissection. Specimens were dried for the herbarium by keeping them in between blotters, after poisoning with absolute alcohol saturated with mercuric chloride. The dried specimens were mounted on standard herbarium sheets, properly labelled, identified and incorporated in the Central National Herbarium (CAL). The details which are generally unobservable in dried specimens, were noted in the field and transferred to herbarium sheets. These details include field number, date of collection, place of collection, altitude, habitat, associated plants, frequency, distribution, flower colour, etc.

The specimens were critically studied and illustrations were drawn. The characters observed were tested with the characters mentioned in the literature. Circumscription of the taxa was delimited with the newly observed characters. The mandatory rules of International Code of Botanical Nomenclature (Berlin Code, 1987) were strictly applied for assessing the nomenclatural and taxonomic status of different taxa of the family. Lectotypes have been selected

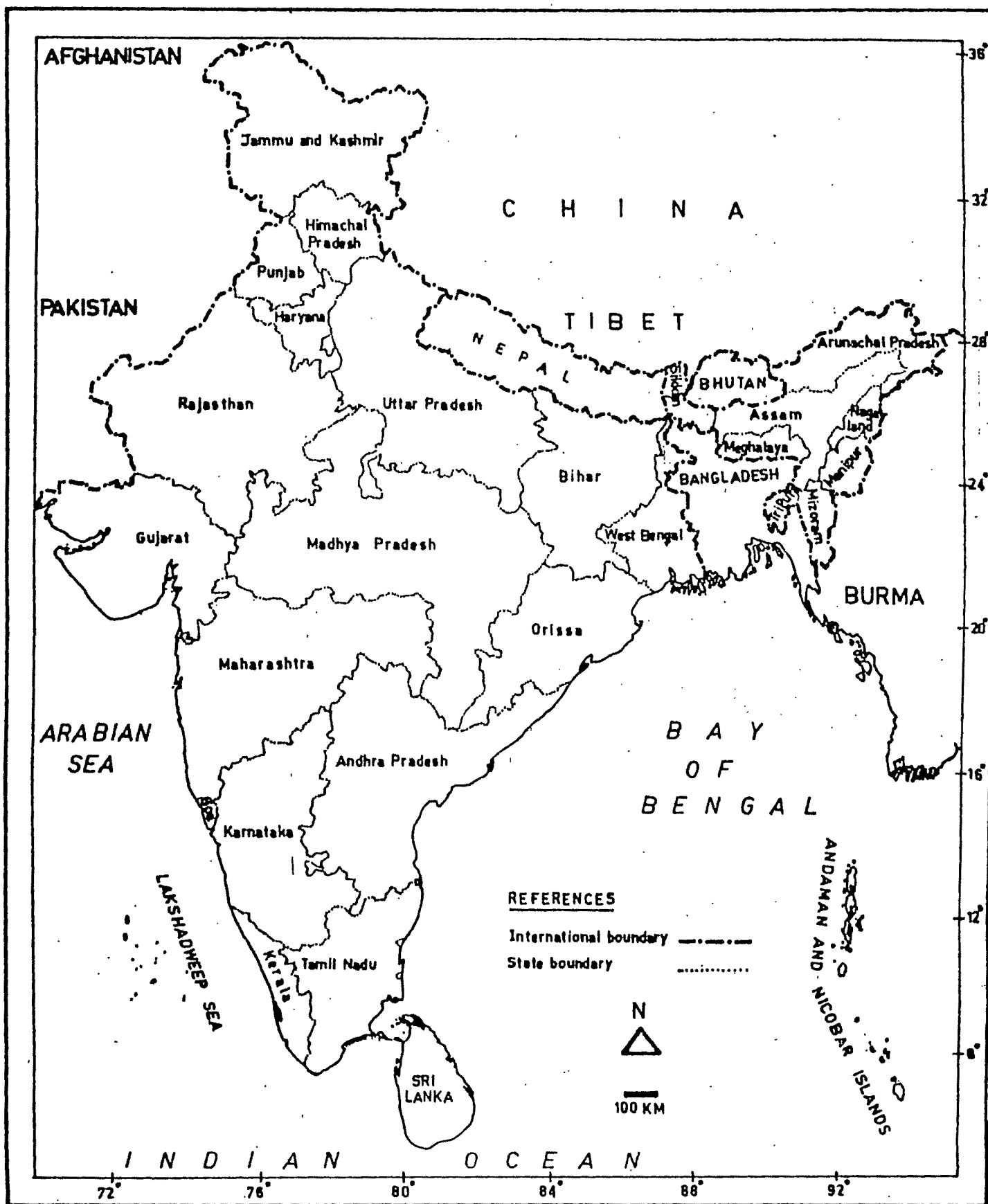
for some species where original description gave syntypes. A key to the genera and keys to the species of each genus of the family are presented. The keys are intended to indicate, as far as practicable, the natural affinities of the taxa by placing those with the most characters in common closest together.

The genera are arranged alphabetically, and each genus contains the correct name and relevant synonyms with original citations and reference to important works and monographs, indication of type species, description, historical and taxonomic consideration, generic relationships, distribution, number of species for the world and for India, chromosome number(s), pollen morphology and key to the species. Under each genus the species are arranged alphabetically.

For each species the correct name is given in bold face. This is followed by all synonyms, in chronological order which are single-underlined. For the correct name and synonyms references to original publications, important floras, monographs/revisions and publications of taxonomic and distributional importance are given. The indication of type specimen <sup>6</sup> are mentioned next. Acronym of the herbarium <sup>(Holmgren)</sup> <sub>et al.</sub>

where the type is deposited is given in parenthesis and if the type specimen is examined for this work, it is indicated by the asterisk mark (\*). When photograph or microfiche is seen, it is clearly mentioned. The local names, if any, are mentioned next. An elaborate description of species is given, followed by flowering and fruiting season, ecology, distribution, chromosome number (if reported), pollen morphology (if available) and notes (if needed) in separate paragraphs. Notes under each species contain important morphological variations, the taxonomic position and diagnostic characters of the species, nomenclatural aspects, etc. The specimens examined and studied are listed statewise and for each state in chronological order of collection with locality, name of collector, collection number and acronyms of herbaria where they are deposited. The names of states are arranged alphabetically. Reference to illustrations and photographs is given at the end of description, and reference to maps given at the end of distribution. The distribution of states in India is shown in Map 1.

Literature references which the author has consulted are given in the bibliography section, in which author's name is given alphabetically.



Map 1. Political units of India

E. KEY TO THE GENERA

- 1a. Aquatic or marshy herbs; calyx tube membranous: (except 1 sp. of *Ammannia*)
  - 2a. Calyx tube campanulate, urceolate or globose, about as long as wide:
    - 3a. Flowers solitary in the axils of leaves or in terminal spikes; capsule dehiscing by valves; the outer wall of the capsule striate ..... Rotala 7
    - 3b. Flowers 3 to many in axillary cymes; capsule dehiscing irregularly or circumsciss<sup>le</sup>, the outer wall of the capsule smooth:
      - 4a. Calyx lobes erect at anthesis, margins and tips smooth; calyx appendages absent or inconspicuous, smooth ..... Ammannia 1
      - 4b. Calyx lobes incurved at anthesis, margins and tips ciliated; calyx appendages prominent, ciliated. .... Nesaea 5
  - 2b. Calyx tube cylindrical, about twice as long as wide ..... Lythrum 4
- 1b. Terrestrial trees or shrubs; calyx tube coriaceous: — not so for *Launsonia* or *Woodfordia*



- 5a. Flowers axillary and solitary; capsule  
circumscissile dehiscent ..... Pemphis 6
- 5b. Flowers in terminal or axillary  
panicles or compact cymes; capsules  
valvular dehiscent, indehiscent or  
irregularly dehiscent:
- 6a. Stamens numerous; capsules dehiscing  
by valves; seeds winged ..... Lagerstroemia 2
- 6b. Stamens twice the number of calyx  
lobes; capsules indehiscent or  
dehiscing irregularly; seeds not  
winged:
- 7a. Flowers irregular, 6-merous; calyx  
tube cylindrical; capsules included  
within the calyx tube ..... Woodfordia 8
- 7b. Flowers regular, 4-merous; calyx tube  
cupular; capsules exserted from the  
calyx tube ..... Lawsonia 3

## I. AMMANNIA

Ammannia, L., Sp. Pl. 1:119. 1753 (excluding A. ramosior L.)  
Gen. Pl. ed. 5:55. 1754; Lamarck, Encycl. Meth. 1:131.  
1783; Jussieu, Gen. Pl. 369. 1791; DC., Prodr. 3:77.  
1828 p.p; Endl., Gen. Pl. 1199. 1836-40; Blume, Mus.  
Bot. Lugd.-Bat. 2(9): 130. 1856 p.p.; Baillon, Hist.  
Pl. 6: 439. f. 456. 1877; Clarke in Hook. f., Fl. Brit.  
India 2: 566. 1879 p.p.; Koehne in Engl., Bot. Jahrb.  
1:240. 1880 & in Engl., Pflanzenr. 17 (4,216): 42.  
1903; Blatter & Hallberg, J. Bombay Nat. Hist. Soc. 26:  
210. 1918; Graham, J. Arn. Arbor. 45: 240. 1964; Iqbal  
Dar in Nasir & Ali, Fl. W. Pakistan 78: 8. 1975;  
Graham, J. Arn. Arbor. 66(4): 402. 1985.

Cornelia Ard., Animadv. Bot. Specim. Alt. 2:9. 1764.

Cryptotheca Blue, Bijdr. Pl. Ned. Ind. 1129. 1826.

Dithea Miq., Fl. Ind. Bat. 1: 615. 1855 p.p.

Diplostemon Miq., Fl. Ind. Bat. 1: 615. 1855.

Hapalocarpum Miq. Fl. Ind. Bat. 1: 618. 1855.

Ammanella Miq., Fl. Ind. Bat. 1: 618. 1855.

Ammannia section 2 Hook. f. in Benth. & Hook. f., Gen. Pl.  
1. 776. 1867.

Lactotype species: *Ammannia latifolia* L., Sp. Pl. 1: 119.  
 1753 (Britton & Brown, Illus.Fl. N. U S. ed. 2(2): 577.  
 1913).

Annual or short-lived perennial, glabrous or papillose herbs of aquatic or marshy habitats. Stems up to 80 cm high, terete or tetragonous, simple to sparsely branched or profusely branched. Leaves decussate, sessile, linear-lanceolate or oblanceolate, attenuate to cuneate or auriculate-cordate at base, acute or obtuse at apex, membranaceous, single nerved. Inflorescence dichasial or polychasial cymes, axillary, sessile or pedunculate. Flowers actinomorphic sessile or pedicellate, 4(-5)-merous; Bracteoles 2, linear, opposite. Calyx tube 1.5-5mm long, campanulate or urceolate, becoming globose or ellipsoid in fruit, 8-nerved, rarely 4-winged, green or red, lobes 4(-5), short and broad, triangular; <sup>ect, margins —</sup> appendages absent or short. Petals 4 or absent, obovate or rotundate, fugacious, very small or larger than calyx lobes, pink, violet or white. Stamens 4-8, included or exserted. Ovary sessile, incompletely 2-4 locular, upper portion of septa incomplete; style simple, longer than to equal or shorter than ovary; stigma capitate, included or exserted. Capsules globose or ellipsoid, membranaceous, included or exceeding calyx lobes, dehiscing irregularly, outer wall smooth, not striated.

Seeds numerous, obovoid, rounded or triangular, concave-convex, 0.4-0.6 long.

#### Historic and taxonomic consideration

The name Ammannia was first applied by William Houston to plants now referred to as A. latifolia L., in his 1736 manuscript of Caribbean collections. Later, in 1737 Linnaeus described the genus Ammannia based on Houston's collections from the Carribbeans and attributed its authority to Houston. The genus was named in honour of Paul Ammann, 1634-1691, Professor of Botany at Leipzig (Linnaeus, 1737). In 1753, Linnaeus in his species plantarum described three species of Ammannia: A. latifolia from the Caribbean, A. ramosior from Virginia and A. baccifera from China. The species A. ramosior of Linnaeus is now transferred to the genus Rotala and referred as Rotala ramosior (L.) Koehne. Linnaeus included the genus in his classis Tetrandria Monogynia.

Roxburgh (1820) considered 6 species from Indian region of which 4 species were newly described by him.

De Candolle (1828) published the first detailed study of the genus Ammannia. He recognised 34 species under 4 subgenera, inclusive of species from Rotala.

Clarke (1879) revised the genus and considered 18 species for British India under 2 subgenera, which include species of Rotala and Nesaea.

In 1903 Koehne published a revision of Ammannia for the world in Engler's Das Pflanzenreich. He recognised 20 species and a number of varieties and forms. He divided the genus into two subgenera and two sections. Subgenus Cryptotheca (Blume) Koehne, comprising the single species A. microcarpa DC., is unique in the Lythraceae by virtue of its parietal placentation. The remainder of the genus comprises subgenus Eu-ammannia, which is further divided into two sections and four series, all highly artificial in nature. Section Astyliia, with short or included styles is represented by A. baccifera L. and A. senegalensis Lamk., section Eustyliia Koehne, with long, exserted styles, by A. octandra L., A. auriculata Willd., and A. multiflora Roxb.

Blatter and Hallberg (1918) considered 6 species for British India, of which one, A. desertorum was described as new.

In the present study 7 species are considered for India. The species, A. nagpurensis is proposed here as new.

### Generic Relationships

The genus Ammannia is closely allied to the genera Rotala and Nesaea. The genera Rotala and Ammannia were long been confused and finally their differences were clarified by Koehne (1880). The superficial similarities of Ammannia and Rotala, as well as Benthams and Hooker's (1867) rejection of Rotala, have necessitated the transfer of at least 45 epithets from Ammannia to Rotala (Graham, 1985).

The genus appears to be most closely related to the genus Nesaea. For example, cymose inflorescences and smooth capsule walls are found in both genera. But the distinguishing characters such as: septa of the ovary complete, placenta continuous with the style, petals corrugated in bud and ciliated bracteoles and calyx lobes in Nesaea are noteworthy.

The septa of the ovary incomplete and placenta not continuous with the style are similar in both the genera, Ammannia and Rotala. However, in the genus Rotala the flowers are axillary solitary, whereas in the genus Ammannia the flowers are in axillary cymes. In Rotala, the capsules dehisce septicidally and the capsule walls are densely striate, while in Ammannia the capsules dehisce irregularly and the capsule walls are smooth.

### Ecology and distribution

The genus grows in wet, relatively open habitats from sea level to 1600 m altitude. It grows in colonies in shallow marshes, temporal pools, roadside ditches, river banks and other inundated areas. In India A. auriculata, A. baccifera, and A. multiflora are predominant troublesome weeds in rice fields.

A genus of world-wide occurrence with about 25 species (Graham, 1985), of which two-thirds occur in Africa. It is also best represented in Asia, Australia, America and Europe. In India, the genus is represented by 7 species.

### Chromosome numbers

$n = 9, 12, 13, 14, 15, 16, 17, 20, 24$  and 33 have been reported for this genus (Graham et al., 1985).

### Palynology

Pollen prolate to prolate-spheroidal, amb circular, protruding in mesocolpal region, tricolporate with six pseudocolpi (heterocolpate), colpi meridionally elongated, equatorially arranged, equidistant, straight, c. 16  $\mu\text{m}$  long, extending within 4-5  $\mu\text{m}$  of pole (PI 0.18), P/E 1.2, margin

more or less entire (slightly undulating at EM magnifications) tapering to acute apex, narrow costae colpi 1  $\mu\text{m}$  wide, colpus membrane minutely granular, ectexine bridge occasionally evident over pore, pseudocolpi slightly shorter (14  $\mu\text{m}$ ), otherwise like colpi; pore circular, diameter c. 2.5  $\mu\text{m}$ , situated at midpoint of colpus, margin entire, faint annulus; Wall 2-2.5  $\mu\text{m}$  thick, finely striate; tectate; 30-34 P X 24-28  $\mu\text{m}$  (Graham et al., 1985).

#### Anatomy

Anatomical features of stem and leaves have been described for eight species by Panigrahi (1980) and the diagnostic features are: Stem - Epidermal cells  $\pm$  rectangular or squarish; 9-35  $\mu\text{m}$  high, mucilage cells of different sizes present. Hypodermis generally parenchymatous of 1 or 2 layers or 1-3 layer of collenchymatous. Cortex aerenchymatous, 2 or 3 layered, air-chambers small and irregular in shape,  $\pm$  transversely elongated, lining cells parenchymatous. Endodermis conspicuous or not. Vascular tissue forms a continuous cylinder. Pith parenchymatous with air spaces, or collenchymatous cells or with fibre cells or hollow in some species. Leaf-Bifacial, flat or conduplicate at midrib only; lamina 40-270  $\mu\text{m}$  thick. Epidermal cells tubular.



Mucilage cells round and oval, elevated or level, solitary or in groups of 2-3 cells. Stomata raised, at level or depressed. Mesophyll of palisade cells in 1 or 2 layers on the adaxial side; spongy cells in 2 or 3 layers on adaxial side, air spaces present or absent. Hypodermis collenchymatous or sclerenchymatous, 1-3 layers on abaxial surface. Bundle sheath indistinct. Midrib large, oval semi-circular or rectangular on the abaxial surface and impressed, shallowly concave with a short furrow on adaxial surface, crescent-shaped with straight or incurved arms.

Key to the species

- 1a. Style thick, c.0.3 mm long  
or less, much shorter than  
ovary, included within  
calyx tube at anthesis:
- 2a. Cymes pedunculate; petals 4 ..... A. senegalensis 7
- 2b. Cymes sessile; petals absent ..... A. baccifera 2
- 1b. Style filiform, 0.75-6 mm long,  
as long as or longer than ovary,  
well exerted at anthesis:

- 3a. Leaves papillose; cymes sessile  
or subsessile; calyx leathery;  
capsules ellipsoid. .... A. desertorum 3
- 3b. Leaves glabrous; cymes pedunculate;  
peduncles 1-15 mm long; calyx  
membranous; capsule globose:
- 4a. Calyx 4-winged; calyx tube 3.5-5mm  
long; capsule completely covered  
by calyx tube. .... A. octandra 6
- 4b. Calyx not winged; Calyx tube  
1-2.5 mm long; capsule exceeding  
the calyx tube:
- 5a. Peduncles and pedicels stout;  
petals 2 to 3 times longer than  
calyx lobes; style twice as long  
as ovary; stamens and stigmas  
reaching above the petals. .... A. auriculata 1
- 5b. Peduncles and pedicels slender;  
petals as long as or shorter  
than calyx lobes; style as long  
as ovary; Stamens and stigmas  
are not reaching above the petals:

- 6a. Plants sparsely branched;  
 peduncles c.15 mm long; calyx  
 lobes rotundate with mucronate  
 apex; flowers and fruits lax ..... A. nagpurensis 5
- 6b. Plants profusely branched;  
 peduncles c. 5 mm long; calyx  
 lobes triangular with acute  
 apex; flowers and fruits crowded .... A. multiflora 4

1. *Ammannia auriculata* Willd., Hort. Berol. 1:7. t. 7. 1872;  
 DC., Prod. 3: 80. 1828; Kurz, J. As. Soc. Bengal 40(2):  
 56. 1871; Koehne in Engl., Bot. Jahrb. 1: 244. 1880 &  
 in Engl., Pflanzenr. 17(4, 216): 45. 1903; Blatt. &  
 Hallb., J. Bombay Nat. Hist. Soc. 26: 212. 1918; Hara,  
 Fl. East. Himalaya 217. 1966; Nair, Bull. Bot. Surv.  
 India. 10: 238. 1969; Stewart, Annot. Cat. Vasc. Pl.  
 West Pak. & Kashmir 499. 1972; Iqbal Dar in Nsir &  
 Ali, Fl. West Pakistan 78: 8. 1975; Hara in Hara &  
 Williams, Enum Flow. Pl. Nepal 2: 171. 1979.

A. racemosa Roth, Catal. Bot. 3: 25. 1806.

A. arenaria H.B.K., Nov. Gen. & Sp. Pl. 6: 190. 1824.

A. senegalensis auct. non Lamk. 1791; Heirn in Olivar, Fl. Trop. Africa 2: 477. 1871 p.p.; Clarke in Hook. f., Fl. Brit. India 2: 570. 1879; Duthie, Fl. Upp. Gange. Plain 350. 1903; Prain, Bengal Pl. 501. 1903; Haines, Bot. Bihar & Orissa 379. 1922.

Ammannia pusilla Sonder, Linnaea 23: 40. 1848.

A. auriculata Willd. Var. arenaria (H.B.K.) Koehne in Engl., Bot. Jahrb. 1: 245. 1880.

Type: Egypt, near Rosette, Willdenow Herbarium 3081  
(Lecto. B-Q; Microfische CAL\*)

Annual, glabrous, erect, herbs. Stems 6-55 cm long, unbranched to multibranched, tetragonous. Leaves 7-60 x 1-10 mm, sessile, linear-lanceolate to linear-oblong, acute at apex, auriculate-cordate or occasionally lowermost ones cuneate at base, clasping. Inflorescences axillary, pedunculate, simple or compound cymes; peduncles 2-8 mm long; flowers pedicellate, (1-) 3-7 (-15) per cyme; pedicels 1-2 mm long; bracteoles 2, 0.5-1 mm long, lanceolate. Calyx tube campanulate, 1.5-2.5 mm long, 8-nerved; lobes 4, c. 0.5 mm long, triangular appendages 4, minutes. Petals 4, 1-1.5 x 1-1.5 mm, obovate, purple or white, showy. Stamens 4, rarely 8, inserted about the middle of calyx tube, exserted. Ovary c. 1 mm long, subglobose, 2-locular;

style c. 2mm long; stigma capitate, exserted, level with anthers. Capsules 2-3.5 mm across, globose; exceeding calyx tube. Seeds many, c. 1 mm long, discoid (Text Fig.1).

Fls. & Frts. : August-December.

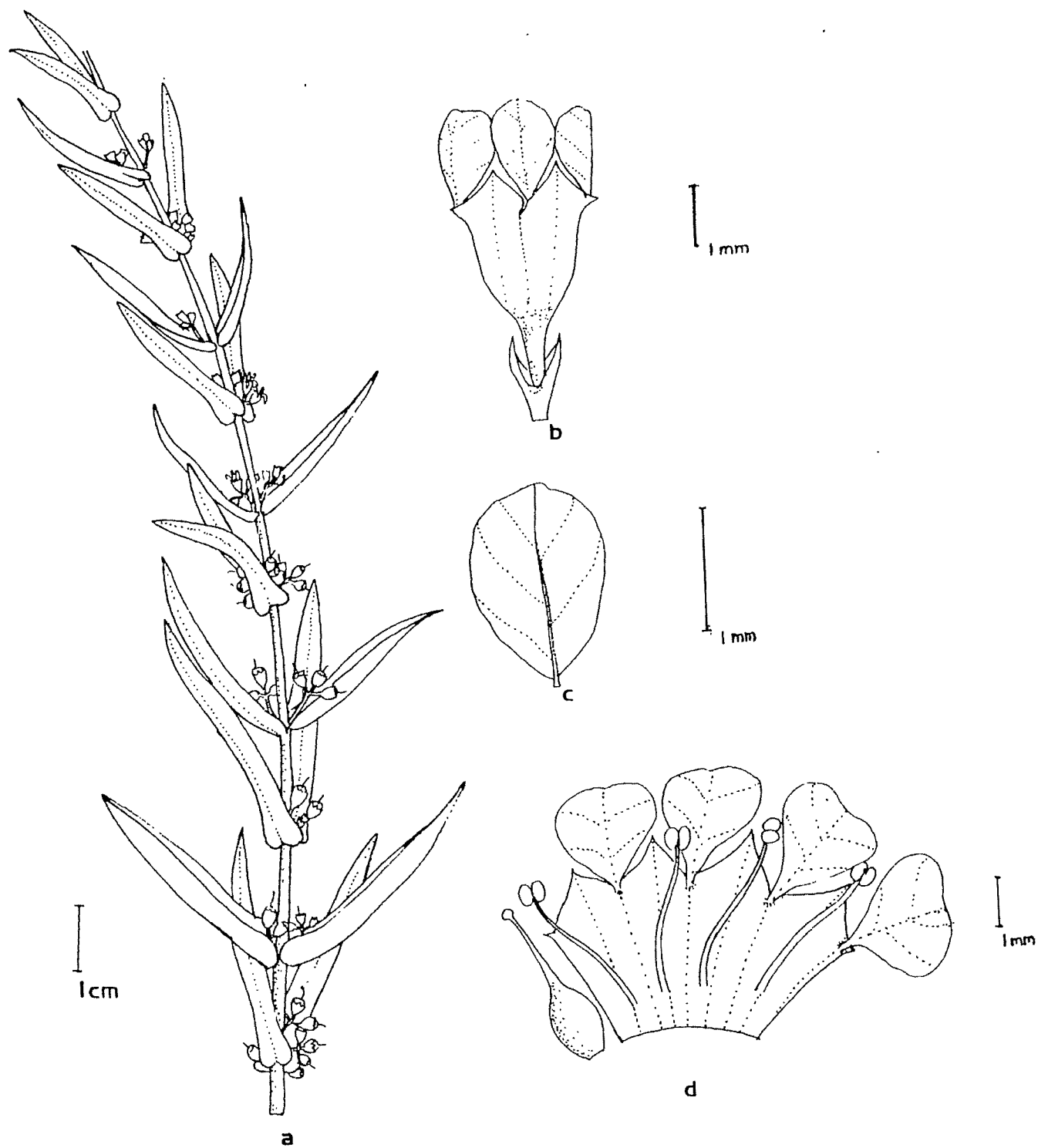
Ecology: Common in rice fields and other wet places.

Distribution: INDIA: Jammu & Kashmir, Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, Rajasthan, Kerala (Vasudevan Nair, 1969); USSR; IRAN; AFGANISTAN; PAKISTAN; CHINA; AUSTRALIA; AFRICA; AMERICA. (Map 1a).

Chromosome number:  $n = 15, 16$  (Graham, 1985)

Notes: (1) Ammannia auriculata resembles A. desertorum but differs in having distinctly peduncled cymes, smooth vegetative parts, very long style<sup>s</sup> which are two times longer than <sup>the</sup> ovary, flowers and fruits lax and globose capsules. While in A. desertorum, the cymes are sessile or subsessile, vegetative parts scabrous papillose, style as long as or shorter than ovary, flowers and fruits crowded and capsules ellipsoid.

(2) Vasudevan Nair (1969) reported A. auriculata from South India, but the author <sup>was</sup> couldn't locate a single collection<sup>s</sup> from any of the herbaria <sup>where located in</sup>.



Text Fig. 1

Specimens examined:

BIHAR: Purnea, between Purnea Dingra ghat, 3.10.1868  
Kurz s.n. (CAL).

HARYANA: Hissar, Babranbir, 23.9.1946, Raizade 21010 (DD);  
 Sirsa, Chhakka Jheel, 2.12.1961, Nair 18981 (BSD);  
 Hissar, between Jind and Hansi, 16.10.1962 Nair 24800  
 (BSD); Hissar, Hansi, 13.2.1963, Nair 25900 (BSD);  
 Hissar, Chakaranian, 26.10.1976, Nair 37642 (BSD).

HIMACHAL PRADESH: Hango, Hazara, 17.10.1897; Inayat 20841  
 (DD)

JAMMU & KASHMIR: Baramula, 1520 m, June 1905, Meebold 390  
 (CAL); Achabal, August 1969, Koul, Dharmadhikari & Koul  
 24 (CAL).

PUNJAB: Hoshiarpur, 16.9.1970, Misra 41833 (BSD); Hoshiarpur,  
 Tanda, 13.9.1979, Daniel 67362 (BSD); Without locality  
Thomson 58 (CAL).

RAJASTAN: Dilwara, Mount Abu, October 1916, Blatter 3337  
 (BLAT); Uvia, Mount Abu, October 1916, Blatter 3338  
 (BLAT); Usrat, Mount Abu, October 1916, Blatter 3339  
 (BLAT); Abu Road, Rajputana, November 1916, Blatter  
 3340 (BLAT); Ganga nagar, Roy 5029 (CAL).

UTTAR PRADESH: Shahjahanpur, Indalpur, bank of Gomati river,  
 11.10.1885, Duthie 4022 & 4023 (DD); Drosh, Chitral,  
 1500 m, 1895, Hamilton 17881 (CAL,DD); Garhwal,  
 Agastyamuni, 19.9.1958 Rau 6356 (BSD); Dehra Dun,  
 Mathron Wale, 13.11.1961, Bhattacharya 18441 (BSD);  
 Lakhaoti, 23.10.1962, Singh 25408 (BSD).

WEST BENGAL: Murshidabad, Lalgola, Guha Bakshi s.n. (CAL).

2. *Ammannia baccifera* L., Sp. Pl. 1: 120 1753; Blume, Mus.  
 Bot. Lug-Bat 2(3): 133. 1856; Dalz. & Gibs., Bombay Fl.  
 97. 1861; Kurz, J. As. Soc. Bengal 40(2): 55 1871;  
 Clarke, in Hook. f., Fl. Brit. India 2: 569. 1879;  
 Koehne in Engl., Bot. Jahrb. 1: 258 1880 & in Engl.  
 Pflanzenr. 17(4,216): 53. 1903; Duthie, Fl. Upp. Gang.  
 Plain 350. 1903; Blatt. & Hallb., J. Bombay Nat. Hist.  
 Soc. 26. 215. 1918; Gamble, Fl. Pres. Madras 510 1919;  
 Haines, Bot. Bihar & Orissa 380. 1922; Kanjilal, Fl.  
 Assam 2: 316. 1938. Santapau, Fl. Saurashtra 1: 226.  
 1962; Hara, Fl. East Himal. 217. 1966; Iqbal Dar in  
 Nasir & Ali, Fl. West Pakistan 78: 9. 1975; Graham, J.  
 Arn. Arbor. 66(4): 405. 1985.

A. indica Lam., Ill. 1: 311. 1791; DC., Prod. 3: 77. 1828;  
 Wight & Arn., Prod. Pen. Ind. Or. 1: 305. 1834;  
 Thwaites Enum. Plant. Zeyl. 121. 1864.



A. aegyptiaca Willd., Hort. Berol. 1: 6. t. 6. 1803.

A. viridis Hornem, Hort. Hafn. 1: 146. 1813; DC., Prod. 3: 80. 1828.

A. vesicatoria Roxb., Fl. Ind. 1: 447. 1820; DC., Prod. 3: 78. 1828; Wight & Arn., Prodr. 1: 305. 1834.

Cryptotheca apetala Blume, Bijdr. Fl. Ned. Ind. 1129. 1826.

Ammannia deblis Blanco, Fl. Philip. 46. 1845.

Hepalocarpum indicum (Lam.) Miq., Fl. Ind. Bat. 1: 618. 1855.

H. vesicatorium (Roxb.) Miq., Fl. Ind. Bat. 1: 618. 1855.

Ammannia salicifolia sensu Hiern in Oliver, Fl. Trop. Africa 2: 569. 1871; Clarke in Hook., Fl. Brit. India 2: 569. 1879 (Non Monti, 1764).

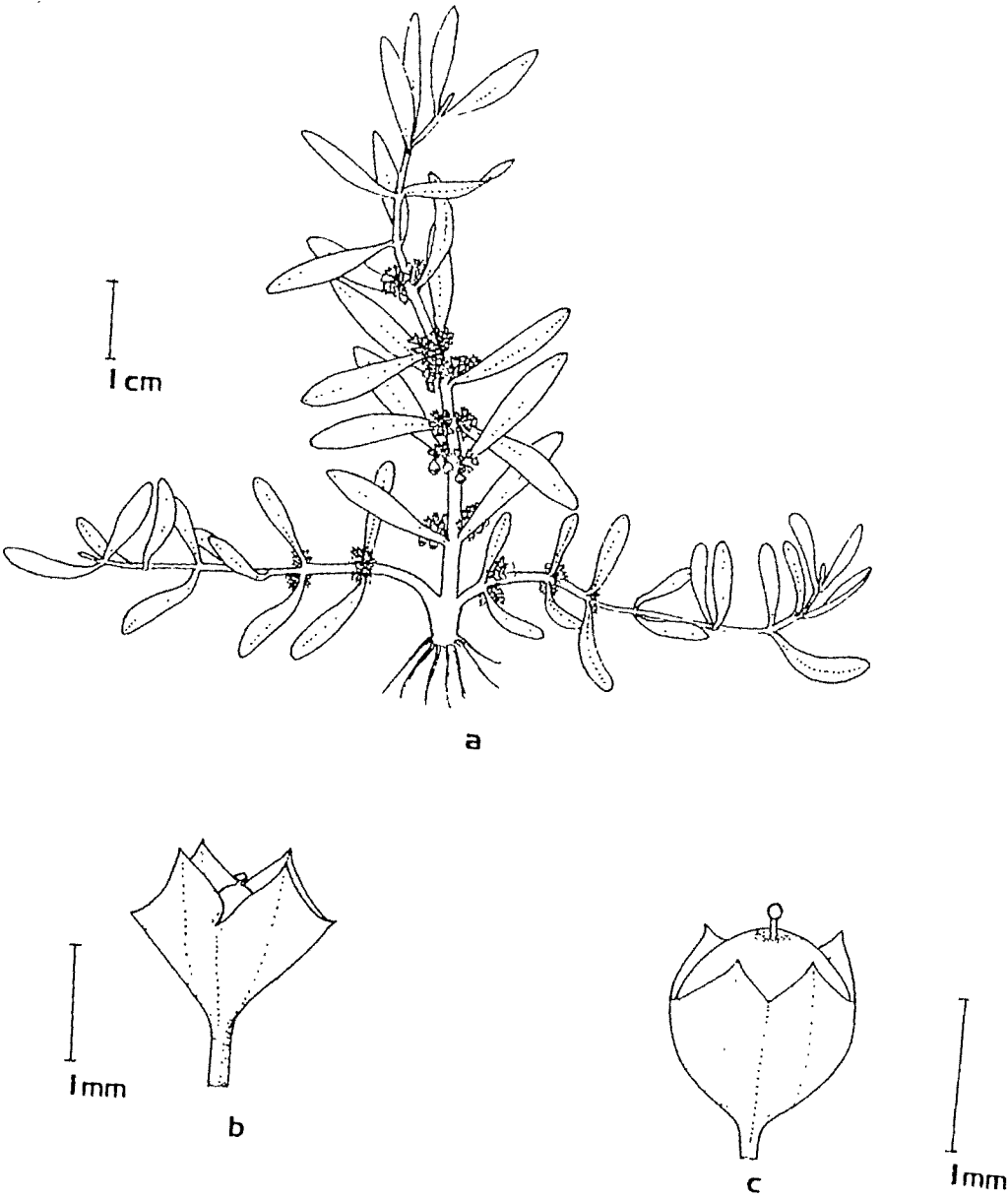
A. baccifera L. subs. viridis (Hornem) Koehne in Engl., Bot. Jahrb. 1: 259. 1880 & in Engl., Pflanzenr. 17 (4, 216): 55. 1903.

A. baccifera L., subsp. aegyptiaca (Wild.) Koehne in Engl., Bot. Jahrb. 1: 260. 1880 & in Engl., Pflanzenr. 17 (4, 216): 55. 1903.

Type: Habitat in China, Osbeck (Lectotype: LINN, Savage Cat. No. 156-4; Microfische CAL\*).

Local Names: Dadmari (Hindi, Bengali); Jalaagio (Guj.); Kalluravanchi (Mal.) Jal-bhangro (Raj.), Nirumel-neruppu, Kallurvi (Tam.); Agnivednapaku (Tel.).

Erect, annual, herbs. Stems 8-80 cm long, tetragonous, often with numerous horizontal or ascending branches from near base to top of stem, greenish or with reddish tinge; branches opposite, axillary, shorter than main stem. Leaves 10-70 x 11-16 mm, linear oblong or oblong-lanceolate, smaller at lower few internodes, gradually larger above, becoming progressively smaller towards apex of stem, acute or obtuse at apex, attenuate to cuneate, rounded or auriculate-cordate at base. Inflorescences axillary, sessile, many flowered cymes, in whorls. Flowers 3 to many per cyme, subsessile or distinctly pedicelled; pedicels 1-2 mm long; bracteoles 2, shorter than pedicel. Calyx tube 1-2 mm long, hemispheric or broadly campanulate, becoming globose in fruit, calyx lobes 4, 0.5-1 mm long, broadly triangular, acute, appendages absent. Petals absent. Stamens 4, <sup>where inserted</sup> included or level with top of calyx lobes. Ovary c. 1 mm long, globose; style c. 0.3 mm long, much shorter than ovary. Capsule 1.5-2 mm across, globose, exceeding calyx lobes. Seeds small, numerous, pink. (Text Fig. 2).



Text Fig. 2

Fls. & Frts. : August - March

Ecology: A very variable species of rice fields and other wet places from sea level to 1600 m altitude.

Chromosome number:  $n = 13$ ,  $2n = 26$  (Sharma, 1970) and  $n = 12$  (Sarkar et al., 1982) have been reported.

Distribution: Throughout India, SRI LANKA; NEPAL; BANGLADESH; CHINA; MALAYSIA; PAPUA; VIETNAM; INDONESIA; CELEBES; NEW GUINEA; PAKISTAN; AFGANISTAN; USSR; IRAN; IRAQ; ARABIA; AFRICA; MADAGASCAR; NORTH AMERICA; WEST INDIES; AUSTRALIA (Map 1a).

Notes: Ammannia baccifera is distinguished from other species of Ammannia by its numerous, minute, densely clustered, axillary flowers that lack petals.

It is widespread and highly variable. Koehne (1880) recognised three subspecies, six forms and two subforms, based on differences in shape of the leaf base - subspecies baccifera with attenuate leaf base, subspecies viridis with cuneate leaf base and subspecies aegyptiaca with auriculate-cordate leaf base. These subspecies occur in the same geographical area. In India all these groups are present but it is very difficult to distinguish them due to

overlapping of characters. In a single gathering all the three leaf base patterns are seen. So in the present treatment the author prefers not to recognise any subspecies or varieties within this taxon.

Specimens examined:

ANDHRA PRADESH: Chittur, Chandragiri, 26.2.1914, S. India Flora 10084 & 10085 (MH); Visakhapatnam, Kishnadevipeta, 6.3.1915, S. India Flora 11728 (MH); West Godavari Kollerulabe, 24.1.1958, Subramanyam 5094 (MH); Hyderabad, along Moosi River bank, 833 m, 24.6.1958, Sebastine 5924 (MH); Cuddapah, way to Guvvalcheruvu, 633 m, 27.2.1959, Subramanyam 7795 (MH); Kurnool, Chelama, 340 m, 7.12.1963, Ellis 17973 (MH); Karimnagar, Kodimial, 400 m, 19.12.1964, Subbarao 21846 (MH); Kurnool, Nallamalais, Mahanadi, 240 m, 10.12.1969, Ellis 32737 (CAL).

ASSAM: Plains of Assam, Mann 431 (CAL); Kamakhya Mandir hill, 18.2.1957, Panigrahi 5379 (CAL).

BIHAR: Chota Nagpur, Palamoo, 1873, Wood s.n. (CAL); Chota Nagpur, Daltonganj, January 1881, Gamble 10170 (DD); Manbhum, 6.12.1883, Clarke 34450 (CAL); Champaran, Manguraha forest, 10.4.1963, Thothathri 10110 (CAL); Champaran, 180 m, 9.11.1963, Shetty 150 (CAL).

GUJARAT: Dharka, Varvala, 7.9.1952, Dhruna 950 (DD);  
Saurashtra, Junagadh, Girnar, 3.10.1953, Raizade 21242  
(DD); Rajkot, beyond Rly. Station 20.10.1953, Santapau  
16866 (BLAT); Shatrunja hill, palitana, 19.8.1960,  
Ansari 63704 (CAL, BSD).

HARYANA: Panipat, 28.11.1961, Nair 18671 (BSD); Karnal,  
15.10.1962, Nair 24617 (BSD); Rohtak, 10.12.1963, Nair  
29723 (BSD); Hissar, Chakaranian, 26.10.1967, Nair  
37641 (BSD).

KARNATAKA: Mysore, Nanjangud, 28.3.1905, Barber 6803 (MH);  
Mysore, Srirangapatna, 725 m, 11.3.1964, Sebastine  
18728 (MH); Mysore, Bandipur-Oogharkeetha, 650 m,  
27.1.1965, Naithani 23186.

KERALA: Palghat, Walayar, 75 m, 29.10.1963, Joseph 17920  
(MH); Trichur, Thunakadavu, 667 m, 28.10.1964,  
Sebastine 22355 (MH); Cannannore, Begur, 800 m,  
3.3.1979, Ramachandran 62009 (CAL, MH); Cannannore,  
Begur R.F., 825 m, 22.3.1980, Ramachandran 66855 (CAL,  
MH).

MADHYA PRADESH: Khandwa, Sendwal, 16.12.1988, Duthie 8296  
(DD); Chindwara, Kotara-Karinji, 31.12.1889, Duthie  
9480 (DD); Rewa, Roopsagar lake, 600 m, 8.2.1959,

Sebastine 7651 (CAL, MH) Saugor, Rahatgarh, near bina river, 470 m, 1.3.1960, Subramanyam 10127 (CAL, MH); Hoshangabad, Bunglapur, Towa river bank, 300 m, 30-9-1960, Joseph 11116 (MH); Mandla, Bichhia, 7.6.1961, Joseph 12221 (CAL, MH); Jubbulpore, Kundwara, 472 m, 12.3.1962, Sebastine 13924 (MH).

MAHARASHTRA: Khandala, 21.11.1948, Santapau 9626 (BLAT); Poona, Rajgad, 10.2.1954, Vartak 2612 (DD); Bombay, Malad, Marve Road, 31.9.1954, Shah 779 (BLAT); Bombay, Madh island, 9.12.1956, Shah 8171 (BLAT); Nagpur, Bhidae tank, 250 m, 13.11.1957, Subramanyam 4562 (CAL, MH).

MANIPUR: On the way to Mao, 1500 m, 19.2.1882, Watt 6114 (CAL, MH)

MEGHALAYA: Garo hills, Nerggitchakgri, Amthol Valley, 18.1.1972, Sangma 5094 (CAL).

ORISSA: Cuttack, North of Mahanadi River shore, 15.5.1906, Ghosh 43 (CAL); Mahanadi, Chamundia, 20.1.1943, Biswas 6280 (CAL); Kalahandi, Jamchna, 600 m, 22.1.1943, Mooney 2178 (CAL).

PUNJAB: Tohana, 19.10.1962, Nair 25008 (BSD); Hoshiarpur, Una, 11.4.1972, Misra 45848 (BSD).

RAJASTHAN: Kotah, Darah, 29.1.1957, Nantiyal 25353 (DD); Lohargal, 10.9.1960, Nair 2094 (BSD).

TAMIL NADU: Thanjavur, Ambasamudram, 23.5.1899, Barber 284 (MH); Coimbatore, Gopinan, 450 m, 11.2.1910, Fischer 1759 (DD); Coimbatore, Perukupatti, 850 m, 27.1.1931, Raju & Naganathan 4983 (MH); South Arcot, Kunduppalanadi, 5.2.1931, Narayanasamy 5098 (MH); Tirunelveli, Courtallam, 400 m, 27.4.1957, Subramanyam 2984 (MH); Tirunelveli, manimuthur Dam area, 300 m, 24.6.1957, Sebastine 3545 (MH); Madurai, Appanthirupathi, 83 m, 20.9.1957, Subramanyam 4300 (MH); South Arcot, Gingee R.F., 120 m, 17.3.1961, Sebastine 12182 (MH); Coimbatore, Nellimalai R.F., 400 m, 22.3.1963, Ramamurthy 16044 (MH); North Arcot, Tippukadu R.F., 165 m, 22.11.1963, Ramamurthy, 17664 (MH); Dharmapuri, Pennagaram R.F., Muthur, 290 m, 1.12.1964, Vajravelu 21996 (MH); Dharmupuri, Hoganakkal River banks, 275 m, 14.3.1965, Vajravelu 23547 (MH); Nilgiri, Kalhatti falls, 1600 m, 12.8.1970, Sharma 35623 (MH); Nilgiri, Anaikatty, 850 m, 21.8.1970, Subbarao 36174 (MH); Chingleput, Vedanthangal, 120 m, 28.1.1976, Henry 47099 (MH); Kanyakumari,



Tambaraparani, Kuzhithurai, 2.8.1977, Henry 49547 (MH);  
North Arcot, Vazhakadu, 800 m, 16.3.1978, Vajravelu  
53432 (MH).

TRIPURA: Agartala, 12.2.1957, Deb 796 (CAL); Jalaya,  
27.12.1959, Deb 2085 (CAL).

UTTAR PRADESH: Lalitpur, 16.1.1888, Duthie 6955 (CAL, DD);  
Gonda, Balrampur, February 1898, Inayat 26970 (DD);  
Bahraich, Nandnala, 15.4.1900, Inayat 23650 (DD);  
Dehra Dun, Mathronwala, 700 m, 27.3.1958, Dakshini 3929  
(BSD); Jhansi, 5.3.1959, Rao 8351 (BSD); Mailani,  
20.12.1960 Malhotra 13444 (BSD); Mirzapur, T. Falls,  
13.2.1961, Bhattacharyya 13612 (BSD); Hamirpur, Mahoba,  
22.7.1962, Malhotra 22813 (BSD); Bulandshahr,  
19.10.1962, Singh 25323 (BSD); Dehra Dun, Sahsradhara,  
13.10.1964, Malhotra 34864 (BSD); Pilibit, Sharda  
Sagar, 2.3.1977, Vora 60234 (BSD); Saharanpur, Laksar,  
October 1984, Murty & Gcel 1304 (BSD).

WEST BENGAL: Sundarbans, 7.11.1901, Prain's collector s.n.  
(CAL); Bankura, Susumi hills, Chhatya, 400 m,  
31.1.1965, Sanyal 524 (CAL); Purulia, Reghunathpur,  
19.2.1970, Malick 1054 (CAL); Midnapore, Belpahari,  
24.11.1975, Maji 2225 (CAL); Calcutta, Brace Bridge,  
27.9.1987, Mathew 13109 (CAL); Calcutta, Ramnagar,  
26.9.1988, Mathew 13113 (CAL).

ANDAMAN & NICOBAR ISLANDS: Port Blair, 10.1.1959, Thothathri 9006 (CAL, MH); Homfray Gunj, 10 m, 15.4.1964, Ellis & Ramamurthy 18834 (MH).

DELHI: Delhi, 23.10.1874, Clarke 23363 B (CAL).

3. *Ammannia desertorum* Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 26: 213. 1918; Sabnis, J. Ind. Bot. Soc. 30. 1924; Stewart, Ann. Cat. Vasc. Pl. West Pak. & Kashmir 499. 1972; Iqbal Dar in Nasir & Ali, Fl. West Pak. 78: 12. 1975; Bhandari, Fl. Ind. Desert 157. 1978; Parmer in Shetty & Singh, Fl. Rajasthan 322. 1987; Kothari in Nayar et al. Ind. Red data Book 2: 148. 1988.

Type: India, Rajasthan, Jaisalmer, Devicot, Nov. 1917. Blatter & Hallberg 3341 (Lecto. CAL, selected here as lectotype); Jodhpur, near Badka, Nov. 1917, Blatter & Hallberg 3347 (Syntype: BLAT).

Local name: Moto-Jal-Bhangro (Raj.)

Annual, <sup>^</sup>scabrid-papillose, erect, herbs. Stem 16-75 cm long, profusely branched, terete below; quadrangular above. Leaves 12-70 x 1-8 mm, linear-lanceolate, acute at apex, auriculate-cordate at base, papillose, midribs prominent

below, margins reflexed. Inflorescences axillary sessile or subsessile cymes, in almost every leaf axils from base to apex. Flowers pedicellate, (1-) 3-7 per cyme; pedicels c. 1 mm long; bracteoles 2, 0.5-1 mm long, subulate. Calyx tube, 1.5-2 mm long, campanulate, 8-nerved, papillose, leathery; calyx lobes 3, c. 0.5 mm, triangular, apiculate, appendages absent. Petals 4, c 1 mm long, obovate, purple, caducous. Stamens 8, inserted on the lower third of calyx tube; anthers suborbicular, borne level with the top of calyx lobes. Ovary 1.25-1.5 x 1-1.25 mm, subglobose or ellipsoid, 2-loculed; style 0.75-1.5 mm long; stigma capitate, slightly exserted. Capsules 2.5-3 x 2-2.5 mm, ellipsoid, exceeding the calyx tube, reddish-brown, transparent. Seeds many, subglobose. (Text Fig.3).

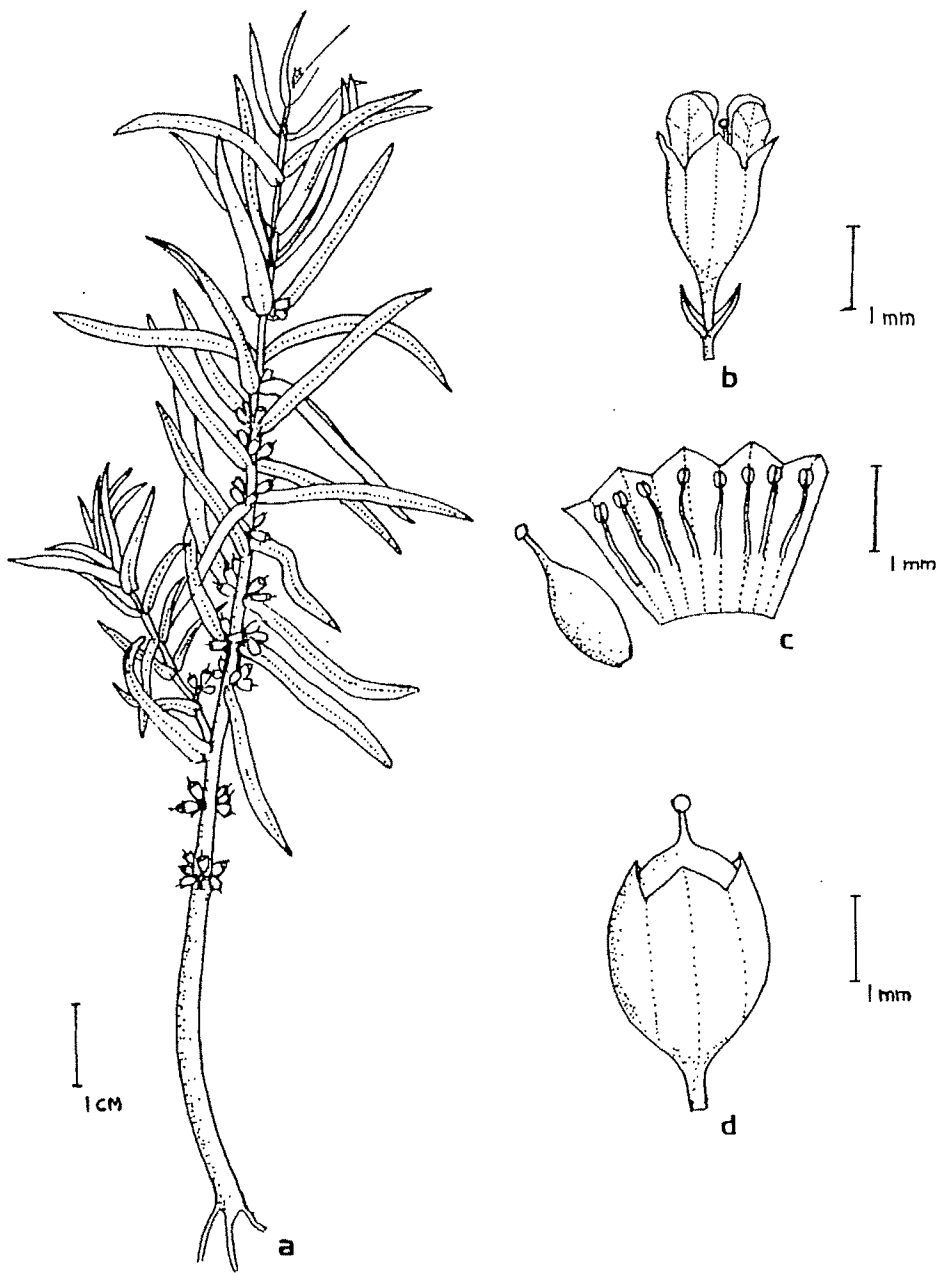
Fls. & Frts.: September - December

Distribution: INDIA: Rajasthan, Gujarat; PAKISTAN (Map 1a).

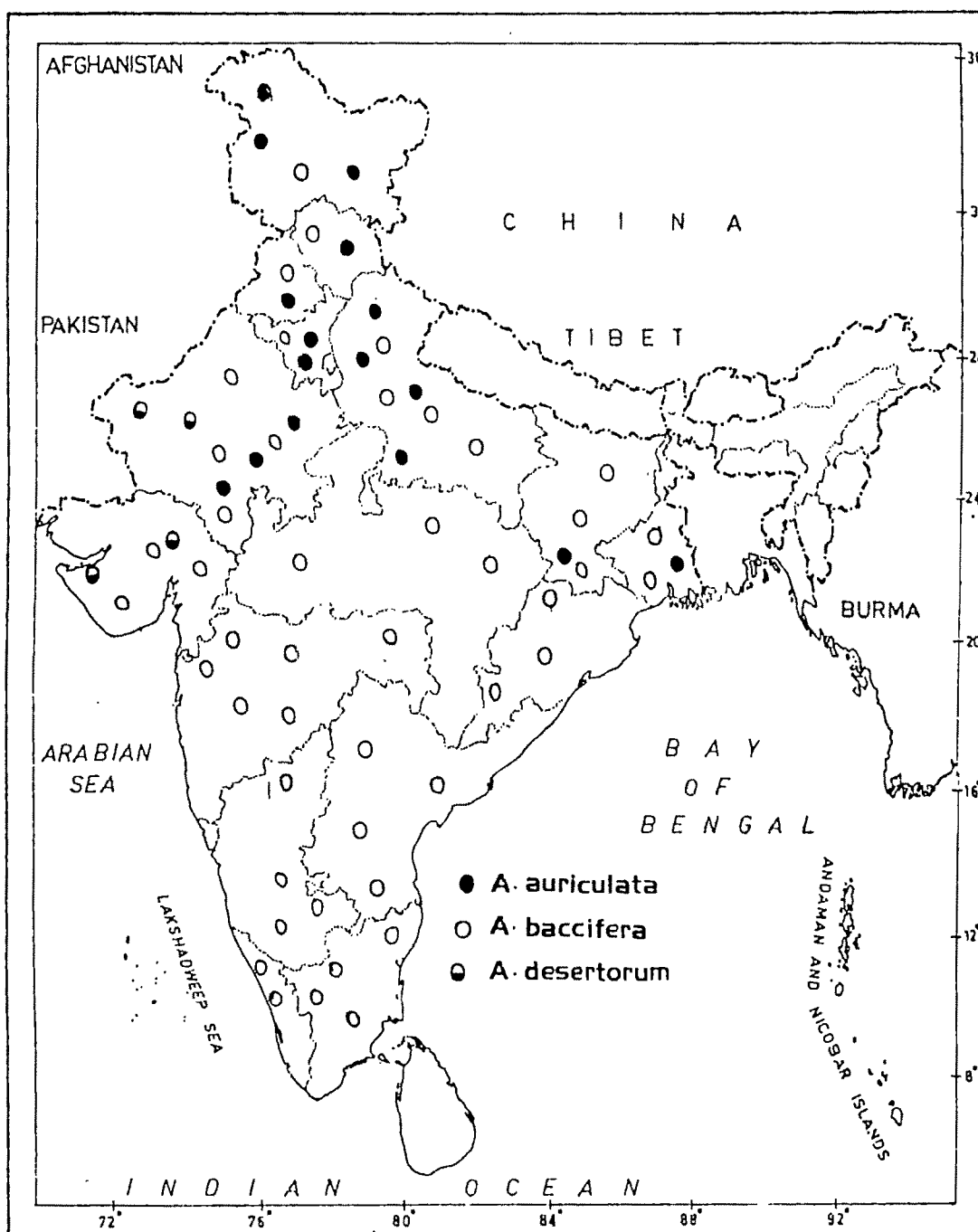
Note: (1) Blatter and Hallberg (1981) mentioned about the type materials in their protologue as "Jaisalmer; Devikot, Nov. 1917, Blatter & Hallberg 3341; near Devikot, Nov. 1917, B. & H. 3342, 3343; Vinjorii, Blatter & Hallberg 3344; Jodhpur, Kotda near Seu Blatter & Hallberg 3345; near Badka on wet ground Nov. 1917, Blatter & Hallberg 3346, 3347".

Text Fig. 3. Ammannia desertorum Blatt. & Hallb.

- a. Habit
- b. Flower at anthesis
- c. Flower dissection
- d. Flower with mature capsule



Text Fig. 3



Map 1a. Distribution of *Ammannia auriculata*, *A. baccifera* and *A. desertorum* in India.

During the study of the specimens of A. desertorum deposited in Calcutta Herbarium and Blatter Herbarium, the author found two specimens, bearing collection numbers 3341 (CAL) and 3347 (BLAT) of Blatter and Hallberg. The remaining specimens are not present in any of the Indian as well as foreign herbaria. Of the available two specimens Jaissalmer, Devikot, Nov. 1917, Blatter & Hallberg 3341 is complete in having flowers and fruits and fully match with the description given by Blatter and Hallberg. Hence the specimen Blatter & Hallberg 3341 deposited in Central National Herbarium, Calcutta (CAL) is designated here as the lectotype for A. desertorum.

(2) IT is closely related to A. auriculata but differs from it by having scabrous-papillose vegetative parts, crowded flowers and fruits, style as long as or shorter than ovary and ellipsoidal capsule.

Specimens examined:

GUJARAT: Ahmedabad, Chharodi, Burkill 16377 (BSIS),  
Jamnagar, Rozi, 16.10.1945, Santupu 7515 (BLAT);  
between Dwarka-Okha, 23.9.1964, Rao 102895 (BSI)

RAJASTAN: Jaisalmer, Devikot, November, 1917, Blatter & Hallborg 3341 (CAL); Jodhpur, near Badka, November 1917, Blatter & Hallberg 3347 (BLAT); Jaisalmer, Devikot, 18.11.1973, Tiwari 867 (BSJO, CAL).

PAKISTAN: Sind, Jamesabad, November 1920, Sabnis B 1150 (BLAT).

4. *Ammannia multiflora* Roxb. Fl. Indica (ed. 1) 1: 447. 1820 & Fl. Indica (ed. 2) 1: 426. 1832; DC., Prod. 3: 79. 1828; Wight & Arn., Prodr. 305. 1834; Dalz. & Gibs, Bombay Fl. 97. 1861; Kurz, J. As. Soc. Bengal 40(2): 55. 1871; Clarke in Hook. f., Fl. Brit. India 2: 570. 1879; Koehne in Engl., Bot. Jahrb. 1: 247. 1880 & in Engl., Pflanzenr. 17 (3, 216): 48. 1903; Cook, Fl. Pres. Bombay 1: 509, 1903; Duthie, Fl. Upp. Gang. Plain 351. 1903; Prain, Bengal Pls. 501. 1903; Gamble, Fl. Pres. Madras 509. 1919; Haines, Bot. Bihar & Orissa 380. 1922; Kanjilal, Fl. Assam 2:316. 1988; Hara, Fl. East Himal. 217. 1966; Stewart, Ann. Cat. Vasc. Pl. West Pak. & Kashmir 499. 1972. Iqbal Dar in Nasir & Ali, Fl. West Pakistan 78: 9. 1975; Hara & Williams in Hara, Enum. Flow. Pls. Nepal 2: 172. 1979.



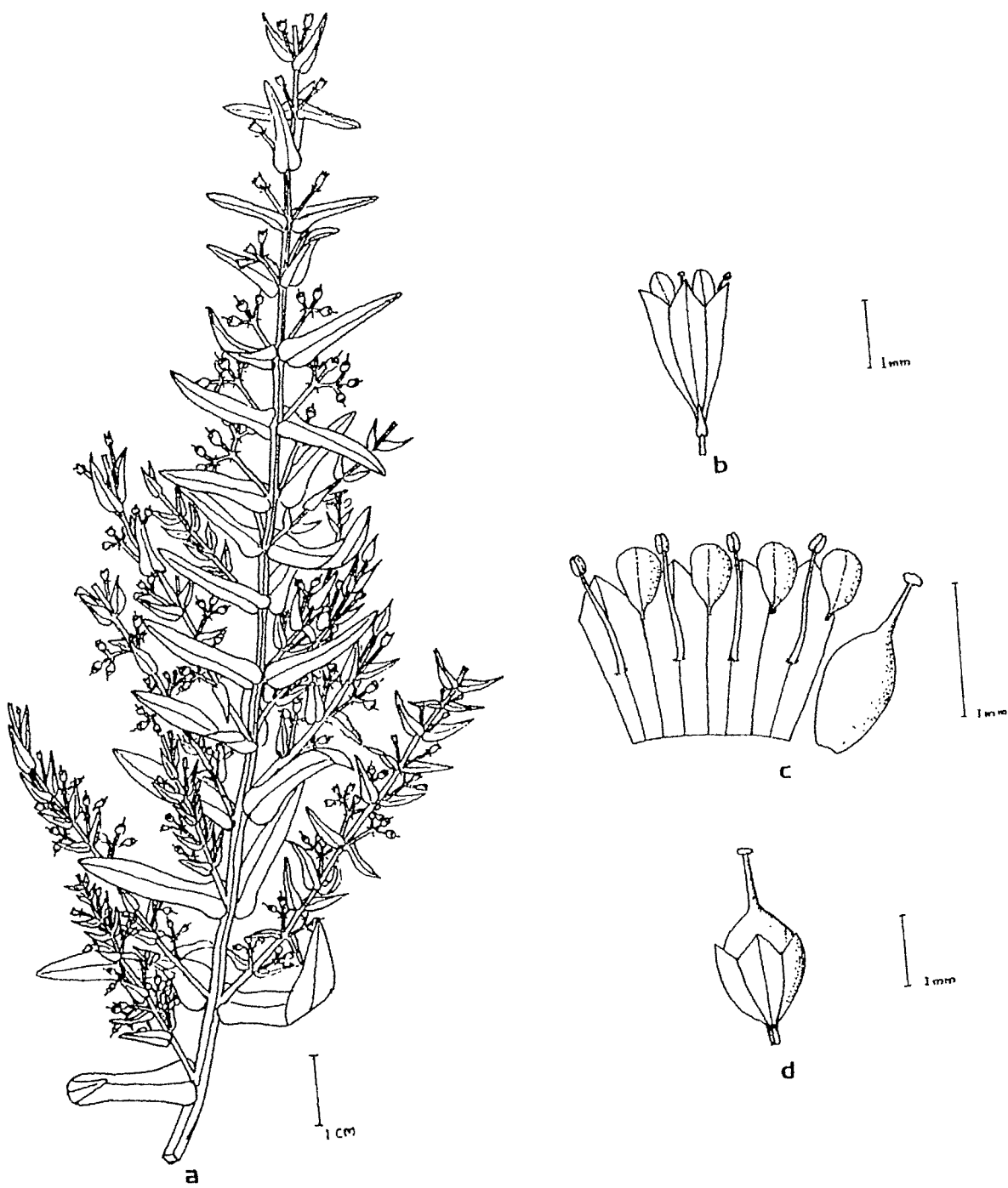
Type: India "a native of open lands about Calcutta", Roxburgh s.n. (Lectotype: K\*, selected here as lectotype); East India, Roxburgh s.n. (Syntype K\*; Photo. CAL\*).

Annual, glabrous, erect herbs. Stems 8-50 cm, long, profusely branched, sharply quadrangular. Leaves 4-30 x 0.5-6 mm, linear lanceolate or elliptic-lanceolate, auriculate-cordate or lower ones cuneate at base, acute at apex. Inflorescences axillary, pedunculate, cymes; peduncles 1-5 mm long; secondary peduncles reaching upto the level of central flower or shorter. Flowers pedicellate, 3-7 (-15) per cyme, pedicels 1-1.5 mm long; bracteoles 2, c. 0.05 mm long, linear. Calyx tube c. 1 mm long, campanulate, 8-nerved, calyx lobes 4, c. 0.5 mm, sharply triangular, acute; appendages minute or absent. Petals 4, c. 0.5 mm long, obovate, cuneate at base, obtuse at apex, caducous. Stamens 4, inserted at the middle of calyx tube; anthers reaching to the level of petals or slightly exceeding. Ovary c. 1 mm long, globose, 2 - loculed; style 0.75-1 mm long; stigma capitate, slightly exserted. Capsules 1-1.5 mm across, globose, exceeding calyx tube. Seeds many, 0.45 x 0.3 mm, triangular-ovoid. (Text Fig.4).

Fls. & Frts. : September - February

Text Fig. 4. Ammannia multiflora Roxb.

- a. Habit
- b. Flower at anthesis
- c. Flower dissection
- d. Flower with mature capsule



Text Fig. 4

Ecology: In paddy fields and other wet places, associated with Ammannia baccifera L. and Ludwigia spp.

Distribution: INDIA: Jammu & Kashmir, Punjab, Uttar Pradesh, Bihar, West Bengal, Assam, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala; USSR; IRAQ; IRAN; AFGANISTAN; PAKISTAN; CHINA; PHILIPPINES; JAPAN; MALAYSIA; AUSTRALIA; AFRICA(Map 2).

Chromosome number:  $n = 9$  (Sarkar et al. 1980)

Notes: (1) Roxburgh did not mention any particular specimen as type in his protologue. About the type he mentioned that, "a native of open lands about Calcutta". There are two sheets of Ammannia multiflora, collected and named by Roxburgh, present at Kew herbarium, of these one was collected from the vicinity of Calcutta and labelled as "native of open lands about Calcutta", and the other labelled as collected from eastern India. After studying the original materials, the author selected the collection Roxburgh s.n. (a native of open lands about Calcutta, Roxburg s.n., K) as the lectotype of Ammannia multiflora Roxb.

(2) It is reported here for the first time from Kerala.

Specimens examined:

ANDHRA PRADESH: Guntur, Repalle, 12.12. 1924, Narayanaswamy  
16810 (MH).

BIHAR: Singbhum, December 1900, Haines 337 (CAL); Palamau,  
Tarwwa hills, December 1958, Sanyal 4(CAL).

GUJARAT: Jamnagar, Rozi, 16.10.1945, Santapau 7514 (BLAT);  
Nawanagar, Kileshwar hills, 31.10.1945, Santapau 7889  
(BLAT); Saurashtra, Okha, 14.10.1953, Santapau 16737  
(BLAT); Okha, Dwarka, 19.10. 1953, Dhruna 3110 (DD);  
Dangs, Waghai, Pimpri Road, 19.10.1954, Santapau 19647  
(BLAT); Dangs, Pimpri, 24.10.1955, Santapau 20133  
(BLAT).

HARYANA: Hissar, 3.12.1961, Nair 17190 (BSD).

KARNATAKA: Kaveripuram, 13.1.1906 Fisher 660 (CAL);  
Shimoga, 600-900 m, October 1908, Meebold 10279 (CAL);  
Dharwar, 750 m, October 1919, Sedgwick and Bell 6618  
(BLAT); Coorg, Kalhalla, 4.1.1959, Arora 46146 (BSI).

KERALA: Quilon, Tenmalai, Mamoodé - Vandalodu, 11.2.1961,  
Subramanian 70563 (BSI); Tenmalai, Mamoodé - Vandalodu,  
25.11.1961, Subramanian 77112 (BSI).

MADHYA PRADESH: Gwalior, December 1889, Equ 201 (CAL);  
 Satna, Near satna town, 400 m, 20.9.1954, Sebastine  
 8894 (CAL); *ibid.*, 22.9.1954, Sebastine 8929 (MH);  
 Hoshangabad, Bunglapur, Towa river bank, 300 m,  
 30.9.1960, Joseph 11099 (MH); Sehore, Rahat garh, near  
 Bina river, 4.11.1960, Balakrishnan 11490 (MH); Mandla,  
 Kheri R.F., 675 m, 26.11.1961, Joseph 13428 (MH).

MAHARASHTRA: Nasik, Igatpuri, January 1917, Blatter 3372  
 (BLAT); Khandala, March 1917, Blatter 3356 (BLAT);  
 Igatpuri, 24.10.1917 Blatter 19188 (BLAT); Poona,  
 December 1917, Blatter 3392 (BLAT); Khandala,  
 22.10.1943, Santapau 3003 (BLAT); Bombay, Borivli,  
 National park, 26.9.1953, Santapau 16110 (BLAT);  
 Bombay, malad, 13.10.1955, Shah 611 (BLAT); Poona,  
 Lonavla, near Valwan dam, 18.8.1964, Venketa Reddi 9937  
 (CAL); Thana, Saihean forest, 26.10.1967, Billore  
 1130054 (CAL).

RAJASTAN: Rajputna, Abu Road, November 1916, Blatter 3383  
 (BLAT); Banswara, Jolana, 8.10.1961, Kanodia 75013  
 (BSD); Chittaurgarh, Hindoli, 23.12.1963, Verma 1894  
 (CAL); Tonk, Kakor, 360 m, 16.9.2974, Shetty 1260  
 (BSJO, CAL); Barmer, Sela forest block, 275 m,  
 16.11.1981, Pandey 8040 (BSJO, CAL).

TAMIL NADU: Madras, 30.1.1899, Barber 124 (MH); Coimbatore, Kollegal, 600 m, 13.12.1905, Fischer 659 (CAL); Coimbatore, Anamalais, 300 m, 12.2.1915, Fischer 11836 (MH); South Coimbatore, Komba, 330 m, 13.2.1915, Fischer 3790 (CAL); Salem, Hoganakkal, 240 m, 13.2.1927, Jacob 18003 (MH); Coimbatore, Kunjur, 850 m, 27.1.1931, Raju and Naganathan 80605 (MH); Tirunelveli; Courtallam, 333 m, 28.7.1957, Subramanyam 3805 (MH); South Arcot, Gingee R.F., 120 m, 21.3.1961, Sebastine 12346 (MH); Chingalput, Manali, 15.1.1988, Mathew 13113 (CAL).

UTTAR PRADESH: Shahjahanpur, Indalpur, Banks of Gumpti, 11.10.1885, Duthie 4024 (CAL, DD); Dehra Dun, Lachiwala, 5.10.1922, Ram 27998 (DD); Mussorie, Kamptee Falls, 1275 m, 9.11.1960, Saxena 1546 (DD); Hamirpur, Mahoba, 27.9.1961, Bhattacharya 17851 (BSD); Dehra Dun, Lachmansid, 27.10.1961, Bhattacharya 17998 (BSD); Pharendra, 31.10.1963, Arora 1410 (CAL); Dehra Dun, Sahasradhara, 4.9.1964, Malhotra 34807 (BSD); Jharia, 25.10.1964, Panigrahi 2055 (CAL); Corbett National Park, 3.10.1980, Pant 72299 (BSD); Saharanpur, Dhandhera, October 1984, Murthy and Goel 1024 (BSD).

WEST BENGAL: Bhirbhum, Caraghola ghat, 31.10.1868, Kurz s.n. (CAL); Burdwan, Dishergarh, 23.9.1972, Banerjee 67 (CAL); Howrah, Indian Botanic Garden, 3.11.1967, Sharma 725 (CAL).

5. *Ammannia nagpurensis* T. Mathew et Nayar, Bull. Bot. Surv. India 31(1-4):158. 1989(1992) Sp. nov.

Affinis A. multiflora Roxb. sed calulibus parce ramosis, pedunculis longioribus (ad 15 mm long 0), calicis lobis subrotundatis, apicem mucronatis, floribus fructibusque laxibus, anthesis plano insertioris petalorum aequis differt.

Typus: INDIA, Maharashtra, Nagpur Dt., Jalankeri farm, 283 m, 20-11-1957, Subramanyam 4717 (Holotypus: CAL).

Annual, glabrous, herbs. Stems up to 30 cm long, erect, sparsely branched, usually with one or two basal branches, four winged. Leaves 3-15 x 0.5-3 mm, linear-oblong, auriculate-cordate at base, acute at apex, entire, semiamplexicaulous. Inflorescences axillary, simple or compound, cymes, pedunculate; peduncles filiform; primary peduncles 8-15 mm long; secondary peduncles c. 7 mm long, reaching well above the central flower. Flowers 3 - 7 (-15)



per cyme, pedicellate; pedicels 1.5-2 mm long; bracteoles 2, 0.25-0.5 mm long, at the base of pedicel. Calyx tube c. 1 mm long, campanulate, 8-nerved, calyx lobes 4, broader than long, subrotundate with mucronate tip. Petals 4, 0.5-1 mm long, obovate, pink, caducous. Stamens 4, inserted on the middle of calyx tube; filaments 0.5-0.6 mm long; anthers reaching to the base of petals. Ovary 0.75-1 mm long, globose, 2-loculed, wall membranous; style distinct, 0.75-1 mm long, persistent in fruit; stigma capitate, slightly exserted. Capsules c. 2 mm across, globose, exceeding calyx tube. Seeds many, minute, 0.35 x 0.25 mm, ovoid, brown.

(Text Fig.5)

Seed morphology (SEM studies)

Ammannia nagpurensis T. Mathew et Nayar (Fig, 27 & 28)

Seeds small, 0.35 x 0.25 mm, ovoid, glabrous, spermoderm cells conspicuous, quadrangular, forming a reticulum, boundary walls unevenly thickened.

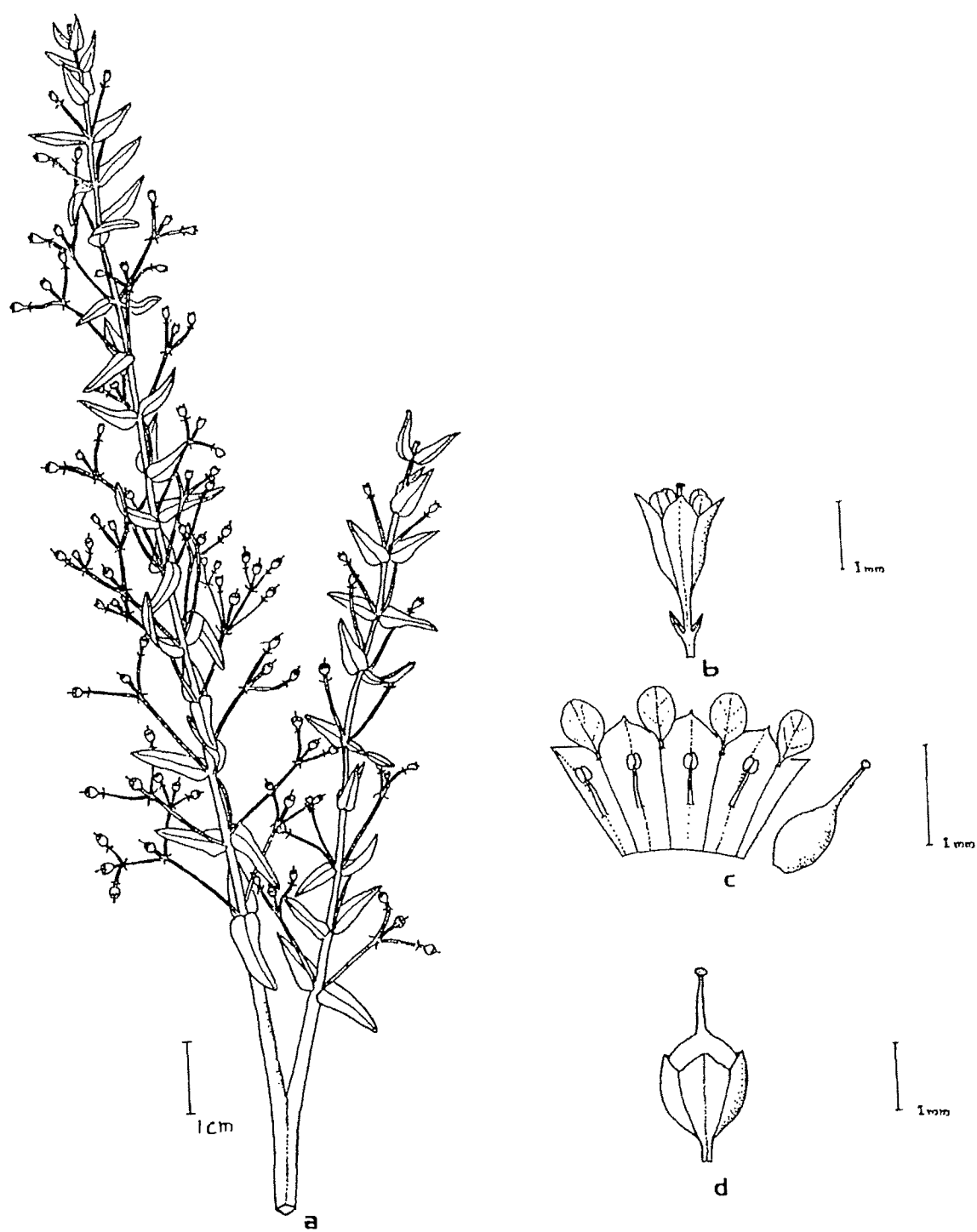
Why here?

Ammannia multiflora Roxb. (Fig. 25 & 26)

Seeds small, 0.45 x 0.3 mm, triangular-ovoid, glabrous, spermoderm cells conspicuous, rectangular, forming a reticulum, boundary walls uniformly thickened with scattered pores throughout.

Text Fig. 5. Ammannia nagpurensis T. Mathew et Nayar

- a. Habit
- b. Flower at anthesis
- c. Flower dissection
- d. Flower with mature capsule



Text Fig. 5

Fls. and Frts. : October - November

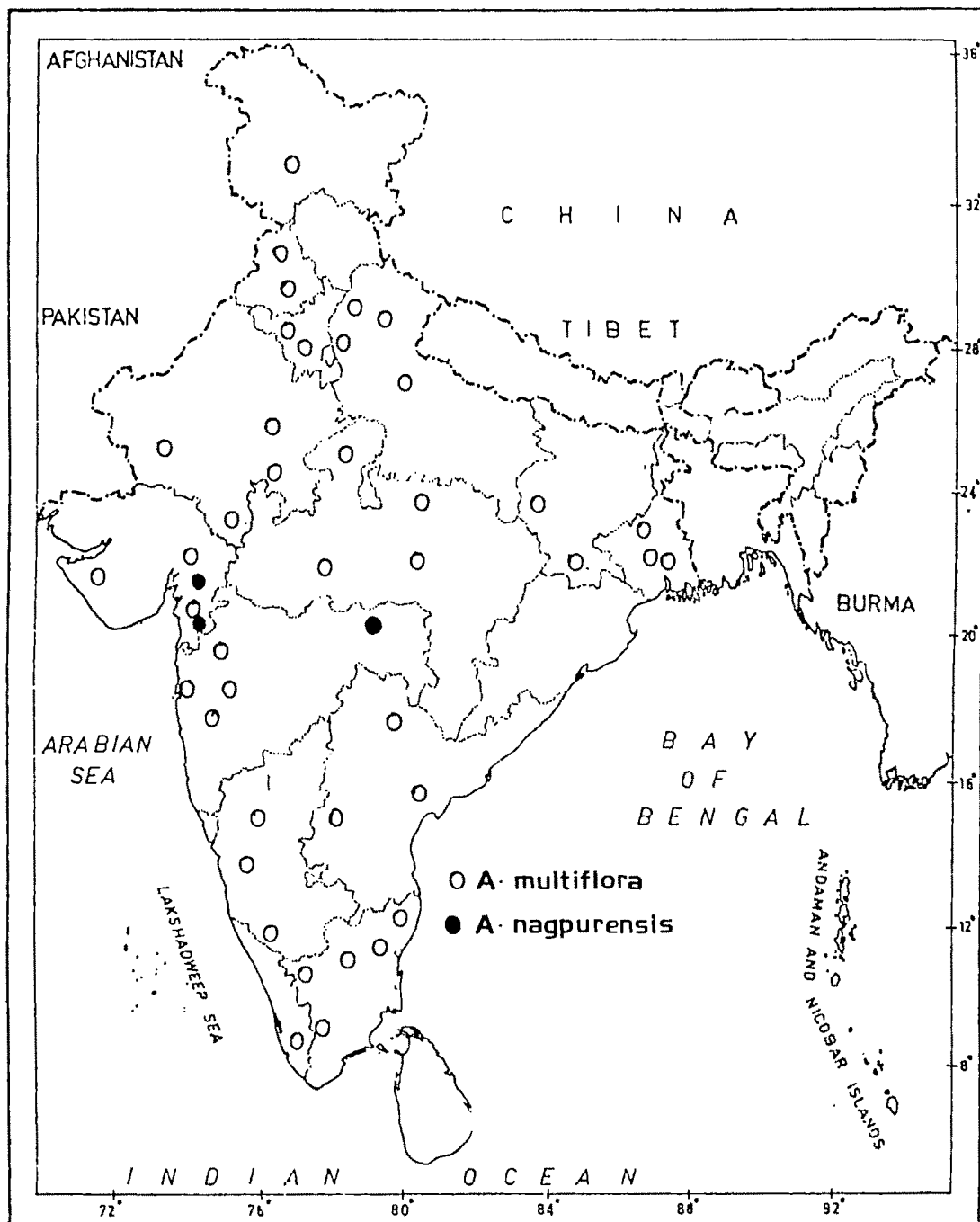
Ecology : Growing in paddy fields, river banks and other moist places.

Distribution: INDIA, Maharashtra, Gujarat:(Map 2).

Note: A. nagpurensis is closely allied to A. multiflora but can easily be distinguished from it by having; sparsely branched stem, very long peduncles (upto 15 mm), subrotund calyx lobes with mucronate tip, stamens level with the point of attachment of petals and flowers and fruits lax, whereas in the latter species stem densely branched, peduncles shorter (upto 5 mm), calyx lobes sharply triangular with acute or acuminate apex, stamens longer than the calyx tube and flowers and fruits crowded.

Spermoderm of both the species have been studied under the Scanning Electron Microscope (SEM) and observed that the shape, orientation as well as thickening of the cells are different from each other.

(2) This species is named after its type locality.



Map 2. Distribution of *Ammannia multiflora* and  
*A. nagpurensis* in India.

Specimens examined:

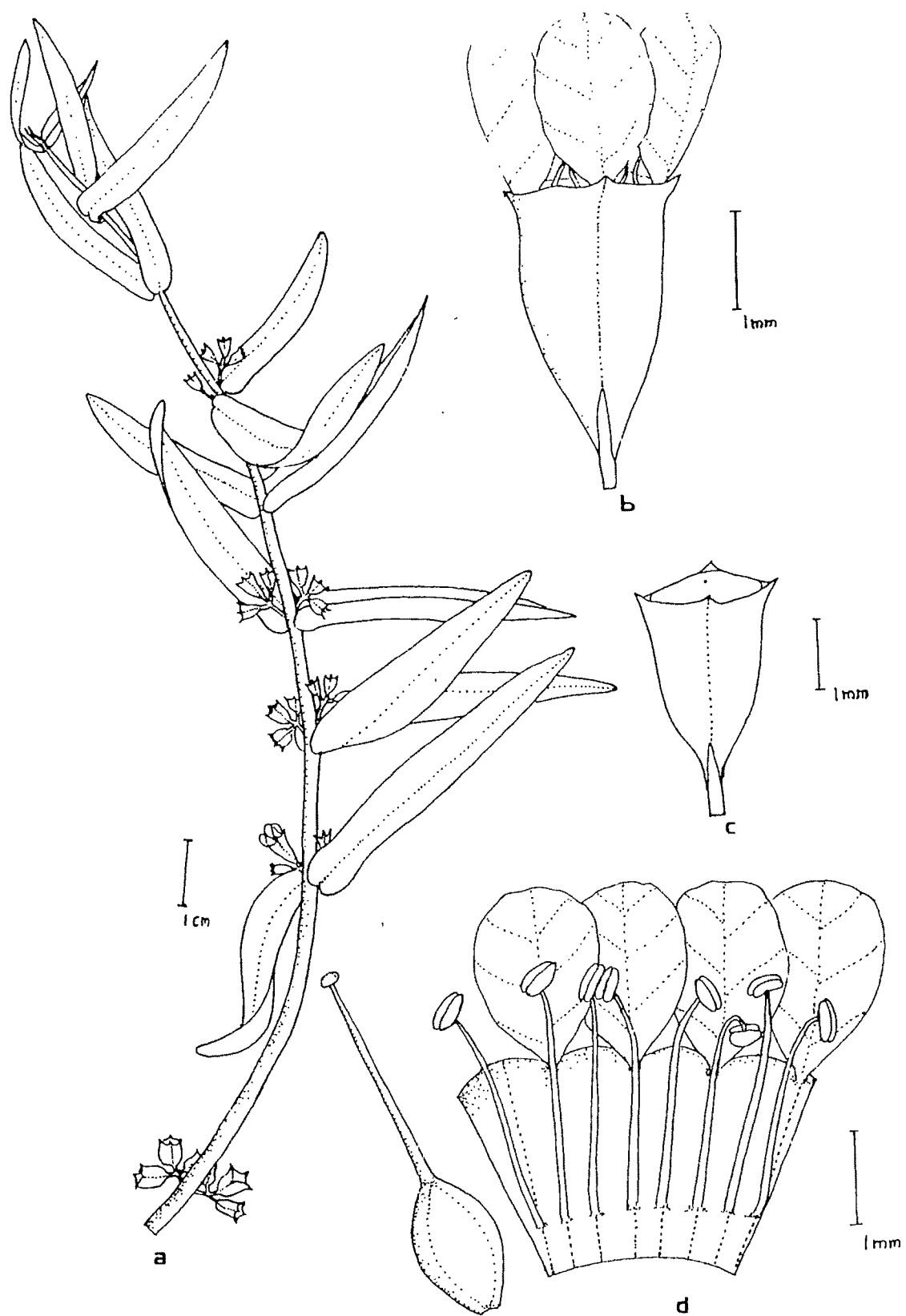
GUJARAT: Saurashtra, Sasan Gir to Janvania, 5.10.1953, Santapau 16359 (BLAT); Dangs, Unai, 3.11.1953, Santapau 17268 (BLAT).

MAHARASHTRA: Nagpur, Starky point, 7.11.1946, Mirashi 252 (BLAT); Nagpur, Jalankeri farm, 283 m, 20.11.1957, Subramanyam 4717 (CAL, MH).

6. *Ammannia octandra* L. f., Suppl. Plant. 8: 127. 1781; Roxb., Cor. Pl. 2: 18, t. 133. 1798 & Fl. Ind. 1: 446. 1820; DC., Prod. 3: 80. 1828; Wight & Arn., Prod. Pen. Ind. Or. 1: 304. 1834; Dalz. & Gibs., Bombay Fl. 97: 1861; Thwaites, Enum. Plant. Zeyl. 121. 1864; Kurz, J. As. Soc. Bengal 40(2): 56. 1871; Clarke in Hook. f., Fl. Brit. India 2: 571. 1879; Koehne in Engl., Bot. Jahrb. 1: 250. 1880 & in Pflanzenr. 17 (4, 216): 50. 1903; Trim., Fl. Ceylon 2: 225. 1894; Cooke, Fl. Bombay Pres. 1: 508. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 26: 211. 1918; Gamble, Fl. Pres. Madras 510. 1919; Mathew & Britto in Mathew, Fl. Tam. Carnatic 3: 606. 1983.

Text Fig. 6. Ammannia octandra L.

- a. Habit
- b. Flower
- c. Flower dissection
- d. Flower with mature capsule



Text Fig. 6



Ecology: Erect gregarious herbs growing on lowlying clayey moist ground or on paddy fields.

Distribution: INDIA: Andhra Pradesh, Tamil Nadu, Karnataka; SRI LANKA; BANGLADESH; CHINA; PHILIPPINES; JAVA.  
(Map 3)

Palynology:  $P = 17-22 \mu m$ ,  $E = 13-20$  PE ratio = 0.85-1.7; grains minutae, spheroid and prolate; pore projected, rimmed, round or oval; amb angulo-triangular or  $\pm$  circular (Panigrahi, 1979).

Specimens examined:

ANDHRA PRADESH: Krishna, 1850, Bleghorn s.n. (MH);  
Godhavari, Rajapalayam, 26.2.1902, Barber 4259 (CAL, MH);  
Samalkota farm, 29.4.1913, Barber 8840 (MH);  
E. Godhavari, Gokavaram, 25.2.1956, Wagh 1761 & 1762 (BLAT).

KARNATAKA: Mysore and Karnatic, without locality, Thomson 18 (CAL);  
Dharwar, March 1868, Brekett 2415 (CAL).

TAMIL NADU: Madurai, Kambam, May 1917, Blatter 3336 (BLAT);  
Madurai, Kambam, January 1918, Sedjwick 3445 (BLAT);

South Arcot, Kumarakshi Road, 6.2.1931, Narayana Swamy 5127 (MH); Tanjore, Umayanathi village, 9.2.1931, Narayana Swamy 5201 (MH); Tanjore, Cada Vasal, 12.2.1931, Narayana Swamy 5228 (MH); on the way to Natham, 200 m, 21.4.1958, Subramanyam 5735 (CAL); Annamalai nagar, sea level, 1.2.1958, Sebastine 5251 (MH); Gingee R.F., 120 m., 18.3.1961, Sebastine 12198 (CAL, MH); Dharmapuri, Gandigan lake, Pennugaram, 460 m, 4.12.1964, Vajravelu 22444 (MH); Ramnad, Esani forest, Sivaganga, 100 m, 16.12.1964, Ramamurthy 22729 (MH); Chidambaram, Sea level, 3.4.1978, Mathew 12643 (CAL); Tiruchi, Uttamarkoil, 65 m, 16.2.1979, Alamelu & Guna 21834 (CAL).

7. *Ammannia senegalensis* Lamk., Ill. 1: 312. t. 77. f. 2. 1791; DC., Prod. 3: 77. 1828; Koehne in Engl., Bot. Jahrb. 1: 255. 1880 & in Engl., Pflanzenr. 17 (4, 216): 52. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 26. 214. 1918; Santapau, Fl. Khandala 97. 1967.

Type: E. Senegal Roussillon s.n. (Microfiche No.238/18, CAL\*).

*of what? Lamme's Herb?*

Annual, glabrous, erect or suberect herbs. Stems 10-30 cm long, simple or with one or two branches, terete below, quadrangular above. Leaves 5-30 x 1-5 mm, sessile, oblanceolate or sublinear, auriculate-cordate or subcordate

at base, rarely lower ones cuneate, acute or obtuse at apex. Inflorescences axillary, subsessile, cymes; primary peduncles c. 1 mm long; secondary peduncles 3-4 mm. Flowers pedicellate, 3-7(-15) per cyme; pedicels short, c. 0.5 mm; bracteoles 2, c. 1 mm long, linear. Calyx tube 1-1.25 mm, campanulate in flower, becoming globose in fruit, 8-ribbed, lobes 4, c. 1 x 1 mm, ovate or round. Stamens 4, inserted at the middle of calyx tube. Ovary 1-1.25 mm long, globose; Styles inconspicuous or absent; stigma capitate. Capsules 2-2.5 mm across, globose, slightly exceeding calyx tube. Seeds numerous.

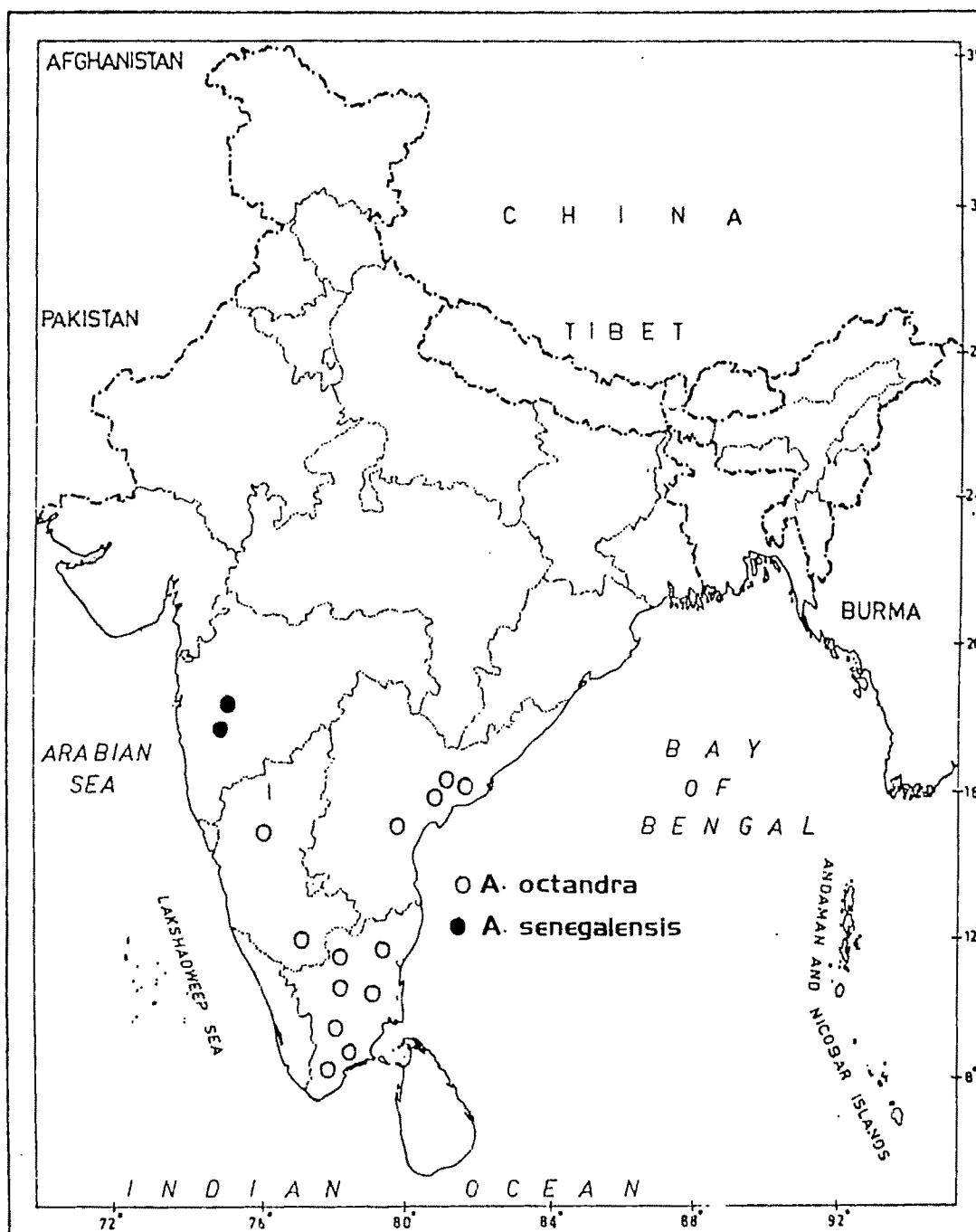
Fls. & Frts. : November - May

Distribution: INDIA; Maharashtra; AFRICA; MADAGASCAR; CHINA; HONGKONG (Map 3).

Chromosome number:  $2n = 40$  (Bir & Sindhu, 1975)

Palynology:  $P = 18-27 \mu m$ ,  $P/E \text{ ratio} = 1.0 - 2.0$ ; grains minutae and madiae, spheroid and prolate; pore projected,  $\pm$  rimmed, circular, amb angulo-triangular or circular (Panigrahi, 1979).

Note: (1) A. senegalensis resembles A. multiflora and A. baccifera; from the first it differs by the absence of style, larger flowers and fruits and sparsely branched



Map 3. Distribution of *Ammannia octandra* and *A. senegalensis* in India.

habit. From A. baccifera, it differs by the presence of peduncled cymes and petals.

(2) This species was first reported from India by Blatter & Hallberg, they described it as a new forma, namely indica. Koehne (1880) described 4 forms in this species. He used the following characters for delimiting them, such as dichasia lax or dense, length of the central pedicel, branching nature, leaves obtuse or acute and leaf bases subcordate or auriculate cordate. In the authors' present study it was revealed that all the above mentioned characters are varying even within a single plant. In a single specimen we can observe leaves with acute and obtuse apices and cuneate to subcordate and auriculate-cordate leaf bases. From a single gathering both simple and sparsely branched habit can be observed. So the forms described by Koehne (1880) and Blatter & Hallberg (1918) are not considered in this treatment.

#### Specimens examined

MAHARASHTRA: Poona, August 1895, Blatter & Hallberg 19866 (BLAT); Khandala, November 1916, Blatter & Hallberg 3350 (BLAT); Poona, December 1917, Blatter & Hallberg 3352 (BLAT), Khandala, Khand Talao and Neighbourhood, 29.5.1944, Santapau 4364 (BLAT); *ibid.*, 29.12.1948, Santapau 9771 (BLAT).

## 2. LAGERSTROEMIA

*Lagerstroemia* L., Syst. Pl. ed. 10: 1076; Retz. Obs. 1:20. 1779 & Obs. 5: 25. 1789; Willd., Sp. Pl. 2: 1178. 1799; DC., Prod. 3: 93. 1828; Roxb., Fl. Ind. (ed. Carey) 2: 503. 1832; Endl. Gen. 1204. 1840; Hook. f. in Benth. & Hook., Gen. 1: 783. 1867; Baill. Hist. Pl. 6: 432. 1877; Clarke in Hook. f., Fl. Brit. India 2: 575. 1879; Koehne in Engl., Bot. Jahrb. 4: 12. 1883 & in Engl., Pflanzenr. 17(4, 216): 252. 1903; Brandis, Ind. Trees, 377. 1911; Furtado & Srisuko, Gard. Bull. Singapore 24: 185. 1969; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan 78: 2. 1975.

Munchausia L., Mant. Pl. 2: 153. 1771.

Adambea Lam., Encycl. 1: 39. 1783.

Fatiao DC., Prodr. 3: 89. 1828.

Type: Lagerstoemia indica L., Syst. Pl. 10: 1076. 1078. 1759.

Shrubs or medium-sized to large trees, 2-40 m tall, glabrous to tomentose, much branched; bark often peeling off in irregular flakes. Leaves opposite, distichous or the uppermost alternate, petiolate, entire, oblong, elliptic,

elliptic-lanceolate or ovate, cuneate or obtuse at base, acute to acuminate or obtuse at apex, prominently reticulate veined on lower surface, coriaceous to chartaceous, glabrous or glaucous beneath, sessile or petiolate. Inflorescences a terminal or axillary panicle. Flowers often large and showy, subsessile or pedicellate, bibracteate. Calyx tube 2-12 mm long, campanulate, coriaceous, glabrous or tomentose, smooth or ribbed, rarely winged, calyx lobes usually 6, sometimes 7-9, ovate or triangular, valvate, glabrous or tomentose without, glabrous or rarely pubescent in the upper half within. Petals usually 6, sometimes 7-9, clawed, orbicular, wrinkled, variously coloured. Stamens numerous, inserted at the base of calyx tube; filaments long, slender, exserted. Ovary sessile, glabrous or tomentose, subglobose or ellipsoid, 3-6 celled, ovules many; style long, filiform, curved; stigma capitate. Capsule globose or ellipsoid, exceeding the calyx tube, base more or less adnate to the calyx, woody, 3-6 valved. Seeds many, elongate, flat, winged.

#### Historic and taxonomic consideration

Lagerstroemia was described by Linnaeus (1759) based on collections from China, with a single species, L. indica. The name was given in honour of Magnus Lagerstroem

(1691-1759), Director of the Swedish East India Company at Gottenburgh, he encouraged Linnaeus and his co-workers in plant collection (Nayar, 1979). In (1770) Linnaeus described the genus Munchausia, according to all subsequent authorities it is synonymous to Lagerstroemia. The genus was first described and illustrated by Van Rheede (1693) under the name 'Adamboe' and 'Katou-Adamboe'. Based on Rheede's name and plate, Lamark (1783) described the genus Adambea with two species, both are synonyms of L. speciosa.

In 1795 Roxburgh described two new species from India, namely L. parviflora and L. reginae. De Candolle (1828) recognised 7 species under 3 sections for the world. The section Sibia DC. is characterised by the calyx being not grooved or folded and six outer stamens longer and stouter, in which he included two species namely L. indica and L. parviflora. He reduced the genus Munchausia of Linnaeus to a section of Lagerstroemia in which he considered two species L. speciosa and L. glandiflora. This section is characterised by calyx not grooved or folded and stamens more or less subequal. The species L. grandiflora now belongs to the genus Duabanga. In his third section Adambea, are included three species namely L. reginae, L. hirsuta and L. floribunda which are distinguished from other sections by the calyx being longitudinally grooved and stamens more or less subequal.



Koehne (1883) published a revision of the genus for the world in Engler's "Botanische Jahrbucher". He recognised 30 species under four sections. The four sections are: Velaga, Muchhausenia, Trichocarpidium and Pterocalymma.

The most recent revision of Lagerstroemia for the world is "A revision of Lagerstroemia L." by Furtado & Srisuko (1969). They considered fifty three species for the world, twelve of which were newly described. They modified the existing classification and recognised three sections: Sibia, Adambea and Trichocarpidium, on the basis of ovary being glabrous or tomentose, calyx ridges as many as or twice as many as sepals. The section Sibia, is with calyx ridges slightly developed or if present as many as sepals and ovary being glabrous. It is again divided into two subsections - Sibia, with calyx ridges slightly developed and Pterocalymma, with calyx ridges distinct, angular or winged. The second section Adambea is characterised by calyx ridges twice the number of sepals and ovary glabrous, comprises three subsections: (1) Adambea with flower buds and fruit larger, calyx glabrous within and ridges distinct (2) Microcarpidium, with flower buds and fruit smaller, sepals glabrous within and ridges clear but superficial. (3) Banqlamea having flower buds and fruits small, ridges distinct and sepal tomentose or pubescent in the upper half

within. The third section Trichocarpidium is unique in having a tomentose ovary is divided into two subsections- Trichocarpidium with calyx lobes glabrous within and Trichosepalum with calyx lobes tomentose in the upper half within.

#### Generic relationships

Results of wood anatomical studies suggest Lagerstroemia is the most advanced genus in the family, combining advanced character states of cryalliferous fibres, abundant parenchyma and homegeneous rays (Bass & Zweypfenning, 1979). The unilaterally winged seeds with revolute cotyledons is unique character of the genus in the family. Koehne (1885) regarded the genus as most closely related to Lawsonia L., a relation supported by wood anatomy. But pollen morphology does not suggest a close relationship between Lawsonia and Lagerstroemia (Graham et al., 1985).

#### Ecology and distribution

The species of Lagerstroemia occur in evergreen forests at altitudes varying from sea level to 1500 m, and generally prefer river banks and water courses.

A genus with c. 53 species of small to large trees native to the South Asian tropics, starts from China and extends upto North Australia. The genus is represented in India by seven species. Fossil leaf impressions of Lagerstroemia have been found in the Lower Eocene Deccan flora of India (Graham & Graham, 1971)

#### Chromosome numbers

$2n = 24, 25, 60$  and  $n = 6$  have been reported for this genus (Mehra, 1976; Ali, 1977; Tobe et al., 1986).

#### Palynology

Pollen prolate to prolate-spheroidal, amb circular to locate (due to prominent mesocolpial ridges); tricolporate with 6 pseudocolpi (hetercolpate), ranging from faint, poorly defined, linear zones paralleling the colpi, to more definite and obvious pseudocolpi, colpi meridionally elongated, equatorially arranged, equidistant, straight, ca. 20-30  $\mu\text{m}$  long, extending within 8-12  $\mu\text{m}$  of pole (Pl 0.3), P/E 1.4, margin dentate, tapering to acute apex, costae colpi 1.5-2.56  $\mu\text{m}$  wide, granular membrane, pseudocolpi shorter (15  $\mu\text{m}$ ), otherwise like colpi, pore prominent, circular to slightly oval, diameter 3-4  $\mu\text{m}$ , situated at

midpoint of colpus, margin entire, annulus 1-2  $\mu$ m wide; pollen dimorphic in some species, in short stamens pollen wall thick, 2-4 (-7)  $\mu$ m at mesocolpial ridge and at poles (polar cap), 1-3  $\mu$ m nearer colpus, 1.5-2  $\mu$ m along colpus, scabrate to finely verrucate, becoming scabrate-punctuate (viz. a more solid tectum) along mesocolpial ridge, distinct columellae evident in most species and prominent in several, especially at poles, in long anthers pollen thinner-walled; 35-55 x 25-40  $\mu$ m (Graham et al., 1987).

Key to the species

- 1a. Shrubs of 2-3 m tall <sup>Better  
Char. needed</sup> ..... L. indica 2
- 1b. Trees of 5-40 m tall
- 2a. Calyx-tube not ribbed:
- 3a. Capsules 10-12 mm long, calyx  
lobes reflexed in fruit,  
fruiting calyx tube cup shaped... L. microcarpa 3
- 3b. Capsules 15-32 mm long; calyx  
lobes appressed to the fruit,  
fruiting calyx tube saucer  
shaped ..... L. parviflora 6

- 2b. Calyx-tube ribbed or winged:
- 4a. Calyx-tube winged; wings as  
many as sepals, undulate ..... L. ovalifolia 5
- 4b. Calyx-tube ribbed; ribs twice  
the number of sepals, entire:
- 5a. Calyx lobes pubescent in the  
upper half within; petals 4-5  
x 2-2.5 mm; capsules 5-6.5 x  
2.5-4 mm ..... L. minuticarpa 4
- 5b. Calyx lobes glabrous within;  
petals 10-36 x 10-26 mm;  
capsules 10-30 x 10-20 mm:
- 6a. Calyx ridges acute; Calyx tube  
5-7 mm long; petals with  
6-8 mm long blade ..... L. hypoleuca 1
- 6b. Calyx ridges flat; calyx tube  
8-10 mm long; petals with 15-  
30 mm long blade ..... L. speciosa 7

1. *Lagerstroemia hypoleuca* Kurz, J. As. Soc. Bengal 41: 307.  
1872 & For. Fl. Brit. Burma 1: 523. 1877; Clarke in  
Hook. f., Fl. Brit. India 2: 577. 1879; Koehne in

Engl., Bot. Jahrb. 4: 30. 1883 & in Engl., Pflanzenr. 17 (4, 216): 262. 1903; Gamble, Man. Indian Timb. 375. 1902; Furtado & Srisuko, Gard. Bull. Singapore 24: 29. 1969.

Type: South Andaman, 23-9-1867, Kurz s.n. (Holo. - K; Photo. CAL\*, Iso. - CAL\*).

A large tree of upto 20 m high. Leaves 10-20 x 4-10 cm, elliptic or lanceolate or oblong-lanceolate, attenuate or obtuse at base, acuminate or rarely acute at apex, dark above, glaucous beneath, coriaceous, margin wavy, 6-16 nerved on either side; petiole 4-10 mm long. Panicles 10-45 cm long, narrowly pyramidal, white puberulous throughout. Flowers sessile or with 2-5 mm pedicel, 6-merous. Calyx tube 5-7 mm long, c. 5 mm broad, campanulate, with 10 acute ridges; lobes 5, 3-4 mm long, triangular, acute. Petals 5, 6-8 x 5-8 mm blade, 4-6 mm long claw, obovate-oblong, margin undulate, lilac. Stamen many, 4-6 with stouter and longer filaments. Ovary c. 1.5 mm long, sessile, subglobose, glabrous; style long, exserted; stigma capitate. Capsules 10-20 x 10-13 mm, oblong, 5-valved, woody. Seeds many, winged (Fig.1).

Fls. & Frts.: June - September.

Distribution: Endemic to Andaman & Nicobar Islands.

(Map 4)

Fig. 1. Type photograph of Lagerstroemia hypoleuca Kurz

A. coccinea Pers, Syn. Pl. 1: 147. 1805, non Rottb. 1773.

Ammannella linearis Miq., Fl. Ind. Bat. 1: 619. 1855.

Diplostemon octandrum Miq., Fl. Ind. Bat. 1: 615. 1855.

Type: India Orientali, Koenig, Linn. Herb. 156/5 (LINN; Microf., CAL\*).

Annual, glabrous, erect, herbs. Stem 20-65 mm long, woody, branched, tetragonous. Leaves 20-65 x 3-10 mm, decussate, sessile, linear-lanceolate, auriculate-cordate at base, acute at apex, entire, clasping. Inflorescences axillary, cymose, subsessile or with 1-3 mm long pedunculate. Flowers subsessile, (-1) 3 per cyme; bracteoles 2, c. 2 mm long, lanceolate. Calyx tube campanulate, 3.5-5 mm long, 4-winged; wings serrulate; lobes 4, c. 0.5 mm, obtuse, appendages 4, longer than lobes, horn like. Petals 4, 2.5-3 x 2-2.5 mm, obovate, crumpled, red. Stamens 8, exserted; filaments red, attached near the base of calyx tube. Ovary c. 2x 1.5 mm long; stigma capitate, level with stamens. Capsules 2.5-3 mm across. (subglobose, completely covered by calyx tube. Seeds c. 0.5 mm long, obovate. (Text Fig.6).

Fls. & Frts: December - May





ESL 176  
5543

No. *Symplocos ignata* Kurz  
South Andaman. Coll. S. Kurz

FLORA INDIA 2 57  
Scribbled by Mr. C. B. CLARKE

Flora of the Andaman Islands 7 Dec 23/19/69

1

Ecology: Scattered in deciduous forests of Andaman Islands.

Uses: Used for making door and window frames, boat building and electrical fitting such as casement boards, switch boards etc.

Specimens examined:

ANDAMAN & NICOBAR ISLANDS: South Andaman, 23-9-1867, Kurz s.n. (CAL); South Andamans, 1884, Kings Collector 329 (CAL); S. Andaman, Chauldari-Hill Jungle, 7.10.1893, King'sH Collector s. n. (CAL); South Andaman, August 1896, Heining 31 (DD, MH); Andaman, 1913, Parkinson 126 (DD); Long Island, July 1915, Parkinson 673 (DD); North Andaman, Bohhington, 8.8.1927, Balasubramanyam s.n. (DD); Middle Andamans, Long Island, 26.4.1964, Thothathri 10796 (CAL); South Andamans, Wright Myo, 16.6.1974, Thothathri 1704 (CAL); Middle Andamans, Tugapur, 15 m, 31.7.1974, Bhargava 3423 (CAL); Little Andamans, Near Ant Bay, 13.1.1976, Bhargava 3423 (CAL); South Andamans, Havelock Island, 30.8.1977, Premnath 5985 (CAL); Middle Andamans, Camp No. 15, 24 km from Rangat, 4.11.1977, Bhargava 6348 (CAL); South Andamans, Baratang Island, Sastri Nala, 29.10.1979, Basu 7400 (CAL).

Flowers 2-3.5 cm across, (-5) 6 (-8) merous; buds subglobose, with a nipple at apex. Calyx tube campanulate, 4-7 x 5-6 mm, faintly (5-) 6 (-7) ridged, glabrous, with pedicelliform base; lobes (5-) 6 (-8), 3.5-6 x 2-5 mm, erect triangular, acute, herbaceous; appendages absent. Petals (5-) 6 (-8), 6-11 x 6-12 mm blade, 6-10 mm long claw, suborbicular, margin crisped, rose or white or violet. Stamens many, dimorphic, 4-6 stouter and longer than the rest. Ovary 2-2.5 mm long, subglobose, glabrous; style 10-12 mm long; stigma capitate, level with the long stamens. Capsule 10-12 x 8-10 mm, subglobose, 4-6 valved, woody. Seeds winged, 6-10 mm long.

Fls & Frts.: May - September

Distribution: INDIA: Assam forests, Himalayan regions; CHINA; JAPAN; BURMA; JAVA; PHILIPPINES; cultivated all over the world as a garden ornamental.

Chromosome number:  $n = 24$  (Ali, 1977)

Notes: A beautiful garden shrub with rose, white or lilac flowers; it is a very variable species. Variation is chiefly found in the shape and size of the flowers and leaves, the colour of petals and the hairiness of the leaves. Koehne (1883) has described two forms, latifolia and angustifolia based on the shape of the leaves.

Specimens examined:

MANIPUR: Imphal, 25.8.1951, Deb 183 (CAL).

ORISSA: Koraput, Salaur, 620 m, 16.5.1959, Rao 18416 (CAL).

RAJASTAN: Banswara, 29.3.1977, Singh 4609 (CAL); Ganganagar,  
10.10.1977, Roy 4983 (CAL).

SIKKIM: Without locality, Sharma 110 (CAL).

TAMIL NADU: Madras, July 1886, Gamble s.n. (MH); Tanjavur,  
Aduthurai, 9.7.1930, Chandrasekharan & Rao s.n. (MH);  
Salem, Nagalur Road - Yerecaud, 1365 m, 18.7.1966,  
Karthikeyan 28289 (MH); Shevaroi hills, without  
collector 110 (CAL); Peninsular India, Herb wight 969  
(CAL).

3. *Lagerstroemia microcarpa* Wight, Ic. Pl. Ind. Or. 1: t.  
109. 1839 & Ill. Eot. 1: 206. 1840; Bedd., Fl. Sylv. t.  
30. 1869; Furtado & Srisuko in Gard. Bull. Singapore  
24: 192. 1969.

L. lanceolata Wall. ex Clarke in Hook. f., Fl. Brit. India  
2: 576. 1879; Koehne in Engl., Bot. Jahrb. 4: 16. 1883

& in Engl., Pflanzennr. 17 (4, 216): 257. 1903; Gamble, Man. Ind. Timb. 372. 1902; Cooke, Fl. Pres. Bombay 1: 513. 1903; Brandis, Indian Trees 338. 1906; Bourdillon, For. Trees Travancore 197. 1908; Talbot, For. Fl. Bombay Pres. & Sind 2: 62. 1911; Gamble, Fl. Pres. Madras 1: 513. 1919; Santapau Fl. Khandala 100. 1967.

L. parviflora sensu Dalz. & Gibbs., Bombay Fl. 98. 1861 non Roxb. 1795.

L. thomsonii, Koehne in Engl., Pflanzennr. 17 (4, 216): 257. 1903; Gamble, Fl. pres Madras 1: 513. 1919.

Type: India, Tamil Nadu, Courtallum, February 1836, Wight 1035 (E, Photo CAL\*)

Local names: Bili-nandi, Benteak (Kan.) Venthekkku, Vellilavu (Mal.); Nana (Mar.); Ventake (Tel.) Vevala (Tam.).

Moderate-sized to large trees. Stems 10-15 m or more tall, 1.5-2 m girth, cylindrical; bark whitish, peeling off in large flakes. Leaves 5-15 x 2.5-7 cm, elliptic-lanceolate, glabrous above, pubescent beneath, acute or acuminate at apex, cuneate at base, nerves prominent beneath, 8-12 pairs; petiole c. 1 cm long. Panicles 10-35 cm

long, 5-25 cm across, terminal or axillary, sub-pyramidal, pubescent. Flowers 2-5 x 2-3 mm, 6-merous. Calyx tube 2-5 x 2-3 mm, campanulate in flower, cup-shaped in fruit, pubescent; lobes 6, 1-2 mm long, triangular, acute, reflexed. Petals 6, 3-5 x 1.5-3 mm blade, c. 1 mm long claw, oblong or obovate, margin crisped. Stamens many, dimorphic, 4-6 thicker and longer than the rest. Ovary c. 1.5 mm long, glabrous, sessile, subglobose; style c. 5 mm long, slender, exserted; stigma capitate. Capsule 10-12 x 6-8 mm, ellipsoid 3-4 valved. Seeds winged, 5-8 mm long.

(Fig. 2)

Fls. & Frts.: May - January

Distribution: Endemic to India: Gujarat, Maharashtra, Tamil Nadu, Karnataka, Kerala, Goa (Map 4).

Ecology: Very common in the mixed deciduous forests of Dangs, Kanara, Malabar and Travancore, usually on Western ghats at 100-1200 m altitude.

Uses: The timber is valuable for making door and window frames and for ship and boat building.

Notes: Furtado & Srisuko (1969) were correct in merging L. thomsonii in L. microcarpa. The pubescence of the leaves are very much varying in this species.

Fig. 2. Type photograph of Lagerstroemia microcarpa Wight





Wright No. 971 [Castellum?]

*Lajuthamia microcarpa* Wright

Det. L. X. Fernald

(9-11/16) 298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000

9. in Coorg in March 1852

*Lajuthamia microcarpa* Wright

Det. L. X. Fernald

Det. 31-11/67

Coorg, March 1852

*Lajuthamia lanceolata* Wright  
Det. Wright  
Distributed at the Royal Gardens, Kew, 1860-7



Specimens examined:

GOA: Durgir forests, 30.8.1963, Kanodia 89655 (BSI); Bhati, Sangueme, 19.4.1966, Cherian 107176 (CAL, BSI); Wolencha dorgan, Carnza, 2.10.1970, Singh, 244938 (BSI).

GUJARAT: Dangs, Waghai, Dungarda, 11.6.1958, Jain 38352 (BSI).

KARNATAKA: North Kanara, 1882, Talbot 60 (CAL); Mysore, Sakarabrile, 24.4.1905, Barber 7023 (CAL); mysore, Bargai, 28.4.1905, Barber 7079 (CAL); Dharwad, Duvicop, 530 m, February 1919, Sedgwick & Bell 5924 (BLAT); North Kanara, Godalli, 25.4.1956, Mahajan 1164, (BSI); Mysore, Harihar Pura, 31.5.1957, Puri 19691 (BSI); North Kanara, Kolegar, 19.2.1962, Raghavan 79550 (BSI); North Kanara, Ghatbagh, 26.3.1964, Raghavan 97209 (BSI); Chickmagalur, Malleswaram, 1.4.1964. Raghavan 97362 (BSI);

KERALA: Travancore, September 1884, Gamble 14729 (CAL); South malabar, Dhoni, 21.1.1910 Fischer 1644 (CAL); Palghat, Attapadi hills, 900 m, 20.5.1911, Fischer 2775 (CAL); Quilon, Road to Aryancavu, 8.9.1913, Calder & Ramaswamy 651 (CAL); Quilon, Tenmalai, 25.11.1961, Subramanyan 77075 (BSI); Calicut, Pavagada, 725 m,

12.5.1965, Ellis 24068 (MH); Palghat, Chindaki forest, 650 m, 1.6.1966, Vajravelu 27754 (MH); Palghat, Panthanthode, 825 m, 18.12.1969, Vajravelu 33117 (MH); Trichur, Machad mala 150 m, 6.4.1977, Ramamurthy 49244 (MH); Cannanore, Begur R.F., 825 m, 23.6.1979, Ramachandran 62742 (MH); Trichur, Vazhachal, 400 m, 23.9.1982, Ramamurthy 74725 (MH).

MAHARASHTRA: Ratnagiri-Kohlapur, Amba, May 1922, Acland 466 (BLAT); Khandala, 6.6.1943, Santapau 2077 (BLAT); Nashik, Igatpuri, October 1957, Santapau 19201 (BLAT); Thane, Khothi, 19.10.1957, Billore 111981 (CAL); Tungar, Mandvi, 9.7.1961, Das 3357-B (BLAT); Khandala, 7.3.1962, Rolla 69748 (BSI); Matheran, 28.7.1966, Wadhwa 109825 (BSI); Ratnagiri, Wasuli, 18.4.1971, Kulkarni 128787 (BSI); Ratnagiri, Adoshi, Koyna, 20.4.1979, Kochar 154391 (BSI); Satara, Tapolaghat, 29.11.1983, 166530 (BSI); Nashik, Igatpuri, Ambewadi forest, 9.10.1988, Narasimhan 166020 (BSI).

TAMIL NADU: Combatore, Anamalais, March 1882, Brandis s.n. (DD); Nilgiris, Devala, 900 m, November 1884, Gamble 15571 (CAL); Nilgiris, Gudalurghat, 1215 m, May 1889, Gamble 20540 (CAL); Castle Rock, October 1908, Meebold

10275 (CAL); Castle Rock, October 1908, Meebold 10275  
(CAL); Coimbatore, Chinnar, 19.7.1910, Fischer 2027  
(CAL).

4. *Lagerstroemia minuticarpa* Debberm. ex P.C. Kanj., Assam  
For. Rec. Bot. 1: 9. 1934; Kanjilal, Fl. Assam 2: 311.  
1938; Furtado & Srisuko, Gard. Bull Singapore 24: 287.  
1969; Mathew & Nayar in Nayar & Shastri, The Indian Red  
Data Book 3: 177. 1990.

Type: India, Assam, Lalinadi, Bereng ghat, Kherempani,  
Bomjur, 150 m, Aug. 1922 U. N. Kanjilal 3107 (Lectotype: CAL,  
DD); Eastern Himalya, Sikkim, Singtam, 1420 m, Ribu & Rhomoo  
(Cave's collector) 6832. (syntype CAL).

Local name: Sinkrit-asing, Kunari-asing (Assam).

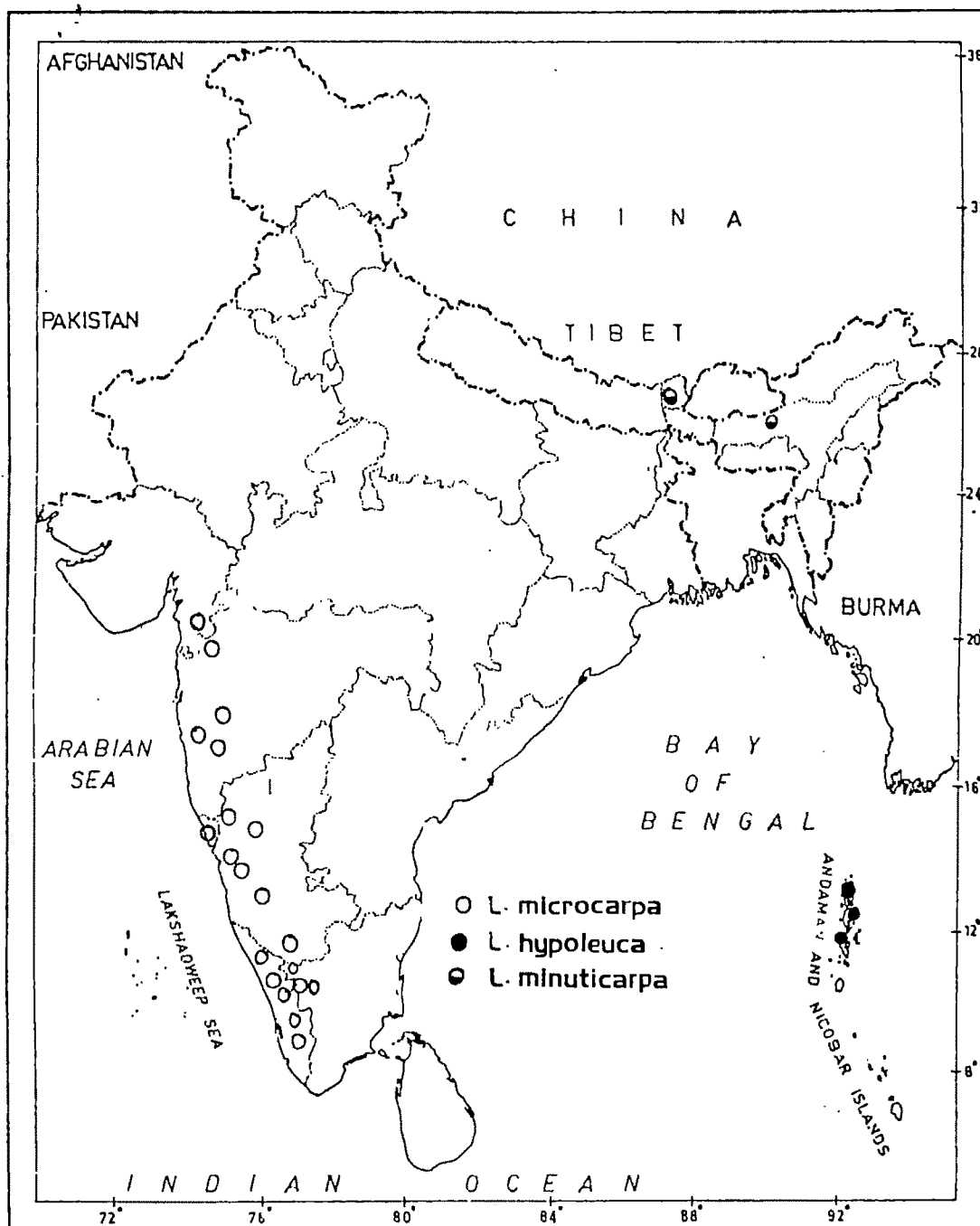
A large tree of 30-40 m high. Leaves 6-14 x 3-7.5 cm,  
elliptic or oblong or ovate-lanceolate, acuminate at apex,  
subrounded at base, sub-coriaceous, glabrous above,  
pubescent on the midrib and veins beneath, 8-23 nerved on  
either side; petiole 7-12.5 mm long. Panicles 9-15 cm,  
terminal, subpyramidal, pubescent. Flowers pedicellate,  
6-merous. Calyx tube 2-4 mm long, campanulate, puberulous,  
12-ribbed; lobes 6, 1.5-2 mm long, triangular, acuminate,

pubescent towards the upper half within. Petals 6, 2.5-5.5 x 2-2.5 mm blade, c. 1.5 mm long claw, obovate-oblong, margins crisped. Stamens 12 or more, 6 stouter and longer than the rest. Ovary c. 1 mm long, stipitate, subglobose, 6-loculed; style 5-6 mm long, exserted, curved; stigma capitate. Capsule 5-6.5 x 2.5-4 mm, ellipsoid, 3-6 valved. Seeds 4-5 mm long, winged.

Fls. & Frts.: June - October.

Distribution: Endemic to India : Assam & Sikkim.(Map 4).

Notes: L. minuticarpa was first described by P.C. Kanjilal in 1934 based on specimens collected by U.N. Kanjilal and P.C. Kanjilal from Assam and Ribu and Romoo (Cave's collectors) from Sikkim. Kanjilal (1934) mentioned about the type material in his protologue "Assam, N. E. Frontier, Lali-Bereng Kherempani, Bamjur 500 ft. U. N. Kanjilal 3107, ibid P.C. Kanjilal 9512, 9513 (Assam) and Eastern Himalaya, Sikkam, 4000 ft. G.H. Cave 6832 (CAL). In the same work after the description, A. Das (1934), editor of the volume, commented that the earlier collections (of U. N. Kanjilal's and Cave's) were insufficient and P.C. Kanjilal made a complete collection of this specimen in sufficient quantity in 1931 and he has thus been able to given detailed description of the plant.



Map 4. Distribution of *Lagerstroemia microcarpa*,  
*L. hypoleuca* and *L. minuticarpa* in India.

But the specimens P.C. Kanjilal 9512 and 9513 are not present in any of the herbaria. Of the available two specimens, the material U.N. Kanjilal 3107 is having authors comments and attached to it the communications regarding the identity of the species is selected here as lectotype.

Specimens examined:

ASSAM: Bomjur, Lalinadi, Bereng ghat, Kherempani, 150 m, August 1922, Kanjilal 3107 (CAL, DD); Lalinadi, Bereng ghat, N.E. Frontier, October 1931, without collector 9805 (ASSAM, DD); N.E.F. Tract, Kerim forest, 27.6.1938, Deka 17041 (ASSAM).

SIKKIM: Singtam, 1420 m, Ribu & Rhomoo (Cave's Collector) 6832 (CAL).

5. *Lagerstroemia ovalifolia* Teijsm. & Binn. Var. ~~*ovalifolia*~~  
Furtado & Srisuko, Gard. Bull. Singapore 24: 213. 1969.

L. ovalifolia Teysm. & Binn., Nat. Tijdschr. Nederl. Ind. 2: 306. 1851; Miq., Fl. Ind. Bat. 1: 624. 1955; Blume, Mus. Bot. Lugd. - Bat. 2: 127. 1856; Koehne in Engl. Bot. Jahrb. 4: 24. 1883 & in Engl. Pflanzenr. 17 (4, 216) 268. 1903; Balakrishnan, Bull. Bot. Sur. India 24 (1-4): 60. 1982.

Type: Described from Java, based on a specimen collected from a plant grown in the Botanic Garden. Bogor.

Small to medium sized trees, 5-20 m tall, with spreading branches. Leaves 6-11 x 4-5.6 cm, ovate to obovate, sub-rounded at base, acute or obtuse at apex, glabrescent on nerves and midrib on both surfaces, black dotted below, 5-7 nerved on each side; petiole c. 5 mm long. Panicle 10-15 cm long, terminal, pyramidal, grey puberulous throughout. Flowers pedicellate, 6-9 merous. Calyx tube 8-12 mm long, 8-10 mm across, funnel-shaped, 6-9 winged; wings undulate; lobes 6-9, 3-4 mm long, acutely triangular. Petals 6-9, 10 x 10 mm blade, c. 5 mm long claw, orbicular, margins undulate, pinkish-purple, early caducous. Stamens numerous, dimorphic, 6-9 longer and thicker, others subequal. Ovary c. 10 mm long, globose, glabrous; style 15-20 mm long; stigma capitate. Capsules 15-18 x 8-10 mm, elliptic-oblong or obovoid, beaked, greenish-brown.

Fls. & Frts.: May - September

Distribution INDIA: Andaman & Nicobar Islands; INDONESIA: (Map 5).

Ecology: Common in lowland forests along coastal areas.

Specimens examined:

ANDAMAN & NICOBAR ISLANDS: Great Nicobar, Campbell Bay,  
24.8.1976, Balakrishnan 3063 (CAL, PBL).

6. *Lagerstroemia parviflora* Roxb., Pl. Cor. 1: 47, t. 66.  
1795; DC., Prod. 3: 93. 1828; Roxb., Fl. Ind. 2: 505.  
1832; Wight & Arn, Prod. Fl. Ind. Or. 308. 1834; Wight,  
Ic. Pl. Ind. Or. 1: t. 69. 1840; Miq., Fl. Ind. Bat. 1:  
622. 1855; Bedd., Fl. Sylv. 1: t. 31. 1869; Kurz; for.  
Fl. Brit. Burma 1: 521. 1877; Clarke in Hook. f., Fl.  
Brit. India 2: 575. 1879; Koehne in Engl. Bot. Jahrb.  
4: 17. 1883; Gamble, Man. Ind. Timb. 371. 1902; Koehne  
in Engl., Pflanzenr. 17(4, 216) 258. 1903; Cooke, Fl.  
Pres. Bombay 1: 512. 1903; Duthie, Fl. Upper Gang.  
Plain. 1: 353. 1903; Prain, Bengal Pls. 1: 503. 1903;  
Brandis, Indian Trees 338. 1906; Talbot, For. Fl.  
Bombay pres. & Sind 2: 61. 1911; Gamble, Fl. Pres.  
Madras 1: 512. 1919; Haines, Bot. Bihar & Orissa 375.  
1922; Kanjilal, Fl. Assam 2: 310. 1938; Hara, Fl. East.  
Himalaya 217. 1966; Hara in Hara & Williams, Enum. Fl.  
Pls. Nepal 2: 172. 1979.

Fatima napaulensis DC., Prod. 3: 89. 1828.



L. lanceolata senu Dalz. & Gibbs., Bombay Fl. 98. 1861;  
Bedd., Fl. sylv. 1: t. 32. 1869 non wall. ex Clarke  
1879.

L. parviflora Roxb. Var. majuscula Clarke in Hook. f., Fl.  
Brit. India 2: 575. 1879; Prain, Bengal Pls 1: 503.  
1903; Haines, Bot. Bihar & Orissa 375. 1922.

L. parviflora Roxb. Var. benghalensis Clarke in Hook. f.,  
Fl. Brit. India 2: 576. 1879.

L. parviflora Roxb. subsp. nudinervis Koehne in Engl., Bot.  
Jahrb. 4: 18. 1883.

L. parviflora Roxb. subsp. pubinervis Koehne in Engl., Bot.  
Jahrb. 4: 18. 1883.

L. parviflora Roxb. var. napalensis (DC.) Koehne in Engl.,  
Pflanzenr. 17 (4, 216); 258. 1903.

Type: INDIA: Circars, Roxburgh s.n. (E)

Local names: Dhauli (Assam); Sidha (Beng.); Sida  
(Hin.); Bondara (Mar.); Bakli, Dhaura (Punj.); Chenangi  
(Tam.); Chinangi (Tel.).

Tall deciduous trees, 15-25 m high 1.5-2 m girth; bark greyish-white, peeling off in oblique flakes. Leaves 3-15 x 1.5-5.5 cm, ovate or ovate-lanceolate or ovate-elliptic, rounded at base, acute or obtuse at apex, glabrous above, glaucous beneath, nerves 6-10 pairs; petioles short, 1-4 mm long, whitish puberulent. Panicles axillary or terminal, 5-20 cm long. Flowers 5-7 mm across, pedicellate, bibracteolate. Calyx tube 3-5 mm long, cupshaped, glabrous or minutely puberulent; lobes 6 (-8), 3-4 mm, triangular, acute or shortly acuminate at apex, closely appressed to the fruit. Petals 6 (-8), c. 3.5 x 2 mm blade, 2 mm long claw, orbicular, margin crisped, caducous. Stamens many, dimorphic, inserted at the base of calyx tube. Ovary c. 2 x 2 mm, globose, glabrous, sessile; style 6-8 mm long, slender; stigma capitate, minute. Capsules 1.5-3.2 x 1-2 cm, ellipsoid, woody, glabrous, 3-4 valved. Seeds winged, 1.5-2 cm long (Fig. 3 & 4).

Fls. & Frts.: April - February.

Distribution: INDIA: Punjab, Uttar Pradesh, Bihar, West Bengal, Assam, Meghalaya, Sikkim, Orissa, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka; NEPAL; BURMA (Map 5).

Chromosome number:  $n = 24, 25$  (Mehra 1976)

Fig. 3. Habit of Lagerstroemia parviflora Roxb.- Field view

Fig. 4. A twig with an inflorescence of Lagerstroemia parviflora Robx.



Ecology: Found in deciduous forests throughout India barring extreme south, at an altitude upto 1500 m.

Use: Wood is used extensively for house building, as posts, beams, bridges, door and window frames etc.

Notes: It is highly variable in the shape, size and texture of leaves and size of the capsules.

Specimens examined:

ANDHRA PRADESH: Cuddapah, Nigadi hill, 750 m, July 1884, Gamble 15213 (MH); Kurnool, Yenacaulais, 450 m, July 1886, Gamble 17697 (CAL); Cuddapah, Ballipalle, 300 m, October 1886, Gamble 18222 (MH); Visakhapatnam, Karaka, May 1900, Barber 1602 (MH); Godavari, Sirivaka, 30.11.1902, Barber 4988 (CAL, MH); Nellore, Veligunda, 27.7.1914, Ramaswami 1334 (CAL); Karimnagar, Kodimial, 400 m, 17.7.1964, Subbarao 20072 (MH); E. Godavari, Rampachodavaram, 300 m, 16.5.1966, Subbarao 27229 (MH); Chittoor, Panapakam, 425 m, 15.6.1969, Subbarao 31875 (MH); Srikakulam, mandasa - Singupuram, 200 m, 7.5.1979, Subbarao 62357 (MH); Visakhapatnam, Cheedipalem, 275 m, 27.9.1980, Subbarao 68607 (MH); Prakasam, Konapalli R.F., 30.1.1985, Mohan 6729 (CAL).

ARUNACHAL PRADESH: Kameng, NEFA, 7.5.1958, Panigrahi  
15101 (CAL)

ASSAM: Kamrup, Prasad-Dhuda, 21.6.1964, Rao 39009 (CAL);  
Kamrup, Baradhoba, R.F., 26.6.1964, Rao 39155 (CAL);  
Nagaon, Kholahat, 1.9.1964, Balakrishnan 39600 (CAL).

BIHAR: Lohardaga, Chota-Nagpur, Sillee, 6.12.1874, Clarke  
25176 (CAL); Lohardaga, Chota-Nagpur, Amjeria, 450 m,  
November 1880, Gamble 8680 (CAL, DD); Santhal Pargana,  
May 1907, Harsukh 539 (DD), Santhal paragna, 19.1.1920,  
Draper 56 (DD).

KARNATAKA: Maisor (Mysore) and Carnatic, Thomson, s.n.,  
(CAL); Mysore, Abbagirai, 20.4.1905, Barber 7002  
(CAL); North Kanara, Yellapur, 600 m, May 1917,  
Sedgwick 2457 (BLAT); Dharwad, Trimalkop, 600 m, March  
1919, Sedgwick 2319 (BLAT).

MADHYA PRADESH: Goona, May 1867, King 81 (CAL); Rewa,  
Govindgarh-Kaimur hills 600 m, 25.4.1960, Sebastine  
10039 (MH); Saugor, Mohli R.F., 500 m, 8.11.1960;  
Balakrishnan 11536 (MH); Baster, Toynar Range, February  
1980, Shahi & Raturi 21 (DD); Rewa, Hanumana, 9.8.1986,  
Prasad 38257 (CAL), Baster, Indravati Tiger Reserve,  
19.5.1987, Anandkumar 16214 (CAL).

MAHARASHTRA: Khandala, 21.3.1942, Santapau 10514 (DD);  
 Bombay State, Sinhagad, 7.11.1956, Patil 9258 (CAL);  
 Kolaba, Bhira, Ambivali, 26.5.1958, Jain 34162 (CAL),  
 Thana, Agoba foot hill, 16.10.1967, Billore 113107  
 (CAL, BSI).

MEGHALAYA: Khasi hills, 600-900 m, May 1877, Kurz 160 (CAL);  
 Khasia & Jaintia hills, 1878, Gallatly 1 (CAL); Khasi  
 hills, Burnihat-Nangpoh, 14.11.1956, Panigrahi 4315  
 (CAL); Khasia, Mann s.n. (CAL); Khasia hills, Simons  
 s.n. (DD).

ORISSA: Mahanadi, April 1873, Gamble s.n. (DD); Ganjam,  
 300 m, March 1884, Gamble 14221 (CAL); Mayurbhanj,  
 Baripada, 30.6.1912, Hooper 38825 (CAL); Ganjam,  
 Sabakota, 13.8.1931, Narayanaswami 5535 (MH); Ganjam,  
 Cerangi, 19.8.1938, Narayanaswami 51817 (MH).

SIKKIM: Teesta, 19.12.1877, King, s.n. (CAL); Badamtan,  
 Rungeet, 24.8.1902, Lace 2358 (CAL); Parhok, 20.5.1907,  
Ribu, s.n. (CAL); Rungtong, 27.5.1912, Ribu & Rhomoo  
 6249 (CAL); Badamtan, 900 m, 10.5.1940, Biswas 4782  
 (CAL).

TAMIL NADU: Nilgiri hills, Thomson s.n. (CAL); Arepalayem, 690 m, 3.7.1930, Narayanaswamy 3346 (DD); Mudumalai, Camp-Kargudi, 900 m, January 1932, Sahu 15 (DD).

TRIPURA: Near Agartala, Abhoynagar, 27.12.1914, Debbarman 388 (CAL); Kunjaban hill, 300 m, 21.10.1915, Debbarman 858 (CAL).

UTTAR PRADESH: Dehra Dun, 1869, King s.n. (CAL); Dehra Dun, June 1895, Mackinnon s.n. (CAL); Gorakhpur, Ramgarh, 25.3.1898, Harsukh 21577 (DD); Kheri, Duhia, 22.4.1898, Inayat 21377 (DD); Pilibhit, Garah, 30.5.1898, Inayat 21576 (DD); Gond, Jankpur, 12.5.1900, Inayat 23651 a (DD); Dehra Dun, Thano, 725 m, 5.12.1900, Kanjilal 942 (DD); Garhwal, Dhara, Jamnafiya, 7.5.1902, Inayat 25892 (DD); Banda, Chitrakoot, 16.11.1957, Rau, 3802 (BSD); Gonda, Tarwa, 28.7.1960, Rau 12091 (BSD); Kumaon, Tanakpur, 14.5.1961, Bhattacharya 15212 (BSD); Mirzapur, 19.9.1961, Bhattacharya 17637 (BSD); Pilibhit, Shardaasager, 2.3.1977, Vohra 60229 (BSD); Tehri, Viyasi, 500 m, 1.4.1979, Goel 65998 (BSD); Saharanpur, Shahjahanpur, August 1985, Murty & Goel 1740 (BSD).



WEST BENGAL: Darjeeling terai, April 1873, Gamble 544 (DD), Darjeeling, Badamtam-Ranjit river, 450 m, 24.7.1902, Lace 2358 (DD); Gangajal Ghati, 28.12.1961, Mukherjee 5467 (CAL); Purulia, Matha Road side, 14.9.1965, Malick 320 (CAL); Burdwan, Maithon Jungle, 4.2.1968, Dutt 1102 (CAL); Jalpaiguri, 31.5.1975, Sikdar 430 (CAL); Purulia, Matha R.F., 11.5.1988, Mathew 13125 (CAL).

7. *Lagerstroemia speciosa* (L.) Pers., Syn. 2: 72. 1807; Koehn in Engl., Bot. Jahrb. 4. 28. 1883; & in Eng., Pflanzenr 17 (4, 216): 261. 1903; Merril, J. Arn. Arb. 25. 146. 1954; Furtado & Srisuko, Gard. Bull. Singapore. 31: 264. 1964; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan 78: 2. 1975.

Munchausia speciosa L., Muenchh. Der. Hans vater 5: 357. t. 2. 1770 et Mant. 2: 243. 1771.

Adambea glabra Lam., Encycl. 1: 39. 1783.

Lagerstroemia flos-reginae Retz., obs. 5: 25. 1789; Bedd., Fl. Sylv. 1: t. 29. 1869; Kurz, For. Fl. Brit. Burma 1: 524. 1877; Clarke in Hook. f., Fl. Brit. India 2: 577. 1879; Trimen, Fl. Ceylon. 2: 228. 1894; Gamble, Man. Ind. Timb. 371. 1902; Cook, Fl. Pres. Bombay 1: 513. 1903; Duthie, Fl. Upper Gang. plain 1: 353. 1903;

Prain, Bengal pls. 1: 503 1903; Brandis, Indian Trees 339. 1906; Bourdillon, For. Trees Travanc. 198. 1908; Gamble, Fl. Pres. Madras 1: 513. 1919; Haines, Bot. Bihar & Oriassa 3: 375. 1922; Kanjilal et al., Fl. Assam 2: 311. 1938.

L. reginae Roxb., Pl. Corom. 1: 46. t. 65. 1795; Willd. sp. pl. 2: 1778. 1800; Wight & Arn., Prod. Fl. Penin. Ind. Or. 308. 1838; Wight, Ic. Pl. Ind. Or. 2. t. 413. 1843; Miq. Fl. Ind. 1: 623. 1855; Blume, Mus. Bot. Lugd.-Bat. 3: 126. 1856; Bedd., Fl. Sylv. 1: 29. 1869; Furtado & Srisuko, Gard. Bull. Singapore 24: 261. 1969.

L. hirsuta (Lam.) Willd. Sp. Pl. 2: 1178. 1800; DC., Prod. 3. 93. 1828; Koehne in Engl., Bot. Jahrb 4: 31. 1883.

Adambea hirsuta Lam., Encycl. 1: 39. 1783.

Type: Described from China, Herb. Linn. 939/1 (LINN; microfische CAL\*)

Local names: Ajhan (Assam); Jarul (Beng., Hindi); Hole-Dasal (Kan.); Taman (Mar.); Manimaruthu (Mal.); Kadali, pumaruthu (Tam.).

Deciduous trees, commonly 7-15 m tall, 2-2.5 m girth, with spreading branches; bark peeling off in irregular flakes. Leaves 5-23 x 3-8.5 cm, oblong or elliptic, acuminate or acute, rarely obtuse at apex, rounded or acute at base, glabrous, 7-15 nerved on each side; petiole 4-10 mm long. Panicles 10-40 cm long, terminal, Pyramidal, grey pubescent throughout. Flowers 5-7 cm across, shortly pedicellate. Calyx tube 8-10 x 6-10 mm, campanulate, 12 ribbed, greyish-brown, tomentose; lobes 6, 7-8 x 4-5 mm, thickened at the margin, spreading or reflexed. Petals 6, 15-30 x 10-25 mm blade, 3-6 mm long claw, sub-orbicular, margin undulate. Stamens numerous, all equal. Ovary c. 6mm across, subglobose, glabrous; style long filiform; stigma capitate. Capsule 2-3 x 1.5-2 cm, subglobose, woody, apiculate, 6-valved. Seeds 1.3-3 cm long, winged, pale-brown (Fig. 5 & 6).

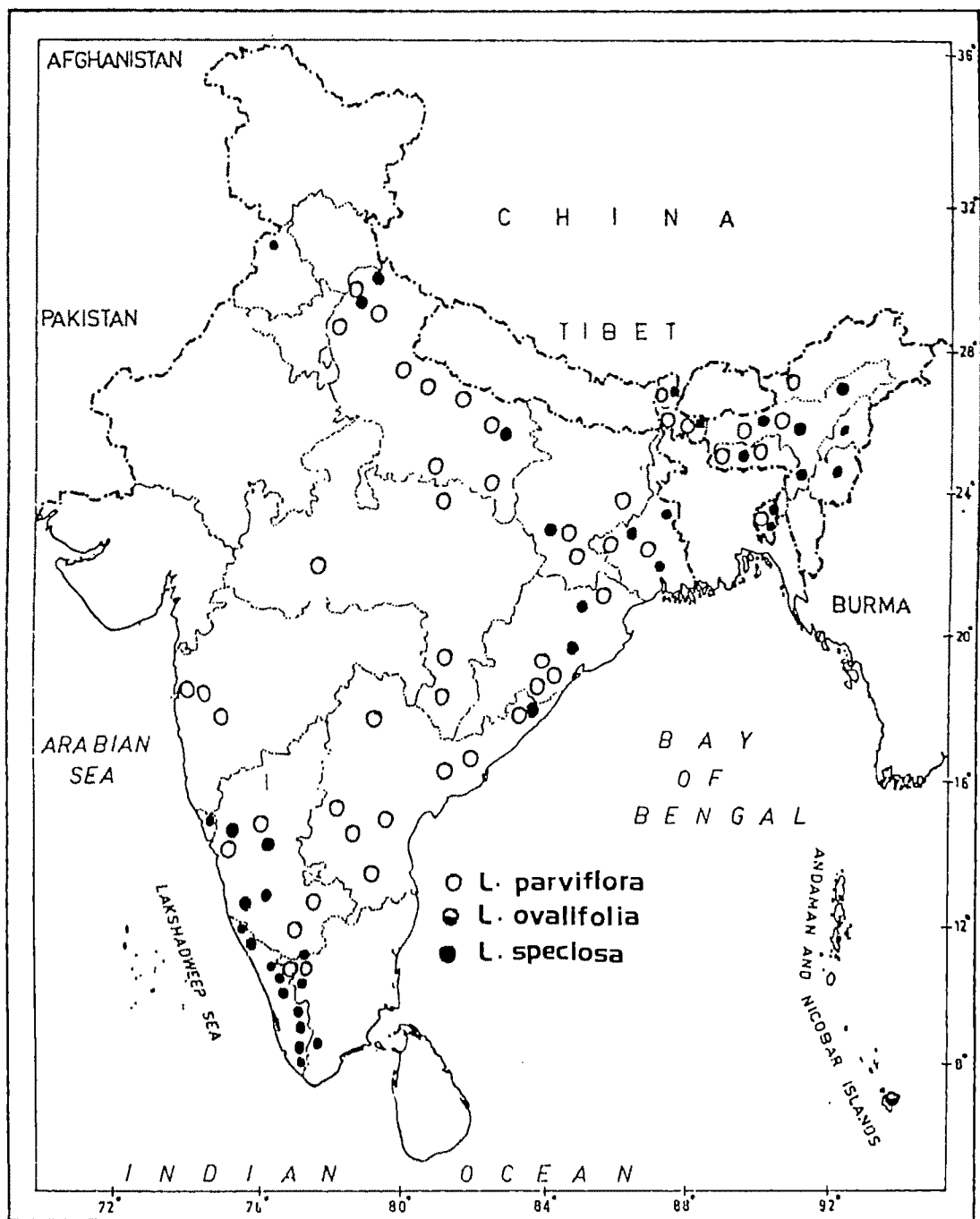
Fls. & Frts. : May - December.

Distribution: INDIA: West Bengal, Assam, Meghalaya, Nagaland, Sikkim, Orissa, Karnataka, Kerala, Tamil Nadu, Cultivated elsewhere; BURMA, NEW GUINEA; THAILAND; INDOCHINA; MALAYSIA; INDONESIA; PHILIPPINES. (Map 5).

Fig. 5. Habit of Lagerstroemia speciosa (L.) Pers. -  
Field view

Fig. 6. An inflorescence of Lagerstroemia speciosa (L.) Pers.





Map 5. Distribution of *Lagerstroemia parviflora*,  
*L. ovalifolia* and *L. speciosa* in India.

Ecology: Deciduous trees generally found along river banks or in areas likely to be flooded. Common at the lower elevations of western ghats from Kerala to North Kanara and in Assam and Bengal.

Chromosome number:  $n = 24, 25$  (Ali 1977, Mehra 1976)

Uses: Its primary uses are for building beams, posts, door and window frames and for boat building. It is much cultivated in avenues and gardens as an ornamental.

Notes: Furtado & Srisuko (1969) considered Lagerstroemia speciosa and L. reginae as distinct species. They reinstated L. reginae on the view that Roxburgh had not included the name L. major (Javanensis) Retz (1779), an earlier name of L. flosreginae Retz. (1789) in his synonymy. But interestingly Roxburgh had mentioned L. flosreginae Retz. as synonymy of L. reginae in his description. Furtado & Srisuko state that L. reginae can be distinguished from L. speciosa by flower buds ashy coloured, sepals thickened along the margins and fruiting calyx spreading. The author has examined large number of specimens, including that determined by Furtado & Srisuko and found that this distinction does not hold good.

Specimens examined:

ANDHRA PRADESH: Srikakulam, Parlakimedi, 150 m, 9.5.1979,  
Subbarao 62373 (MH).

ASSAM: Nangpoh, April 1893, King's collector s.n.(DD);  
 Sonaimookh, 20.8.1903, Gage s.n. (CAL); Badapur,  
 November 1907, meebold 5650 (CAL); Nowgong, Jamunamuk,  
 12.5.1935, Datta 1 (DD); Cachar, Silchar, 26.6.1937,  
D.F.O 16674 (DD); Lakhimpur North, 9.4.1964,  
Balakrishnan 39226 (CAL); North Lakhimpur, 16.5.1976,  
Verma 46379 (CAL).

BIHAR: Chota Nagpur, January 1881, Gamble 9094 (CAL).

GOA: Durgir Forests, 30.8.1963, Kanodia 89657 (BSI).

KARNATAKA: South Kanara, 1855, Beeddome s.n. (MH); Canara,  
 1857, Cleghorn s.n. (MH); North Kanara, 15.5.1896,  
Talbot 3672 (CAL); South Kanara, Sampago, November  
 1900, Barber 2270 (MH); Coorg, December 1917, Tiseman  
 s.n. (DD); Dharwad, Kadra, 4.5.1950, Braganza 148 (DD);  
 South Kanara, 22.7.1978, Ramesh 1913 (CAL).

KERALA: Cannanore, Taliparamba, 13.6.1905, Barber 7366 (MH);  
 ibid, 19.5.1906, Barber 7741 (CAL, MH); Elival, South  
 Malabar, 8.6.1910, Fischer 1982 (CAL); Trichur,



Chalakudi, November 1910, Meebold 12489 (CAL); Travancore, Nadvanthurai, 25.8.1913, Calder & RamaSwamy 110 (CAL); Palghat, chenat rain forests, 8.1.1935, Range Officer 703 (DD); Trichur, Parambikulam, 607 m, 30.12.1963, Ramamurthy 20022 (MH); Idikki, Pallivasal, 1225 m, 23.4.1964, Sebatine 18385 (MH); Palghat, Dhoni R.F., 100 m, 27.5.1964, Vajravelu 19105 (MH); Idikki, Thekkady, 875 m, 28.5.1965, Vivekananthan 24354 (MH); Cannanore, Chandanathodu, 900 m, 24.6.1965, Ellis 25118 (MH); Palghat, Mukkali forest, 525 m, 3.6.1966, Vajravelu 27793 (MH); Malappuram, Nilumbur, 75 m, 1.8.1970, Ellis 35333 (MH); Trivandrum, Klamala R.F., 225 m, 11.4.1973, Joseph 44155 (MH); Trichur, Peechi range, 100 m, 4.9.1976, Ramamurthy 47610 (MH); Quilon, Thannithode R.F. 200 m, 11.4.1978, Mohanan 54998 (MH); Cannanore, Aralam, 250 m, 27.4.1979, Ramachandran 61616 (MH); Pathanamthitta, Ranni R.F., 350 m, 25.5.1979, Mohanan 63467 (MH); Trivandrum, Pulimath, Riverbank, 125 m, 27.5.1979, Mohanan 63295 (MH); Trichur, Adirappally Water falls, 350 m, 17.3.1982, Rajan 73046 (MH); Kasargod, Parappa, 300 m, 8.5.1982, Nair 71084 (MH); Trichur, Vazhachal to Sholayar, 400 m, 23.9.1982, Ramamurthy 74757 (MH); Pathanamthitta, Konni R.F., Kadambupara River bank, 20.4.1984, Vajravelu 80532 (MH).

MADHYA PRADESH: Singhurauli Coal fields, 15.8.1978, Roy &  
Sukal 42295 (CAL).

MANIPUR: Imphal, Chingrumathalai, 13.7.1951, Deb 274 (CAL);  
Without locality Deb 4 (CAL).

MEGHALAYA: Khasia & Jaintia hills, July 1878, Gallatly 396  
(CAL); Bornihat, 16.6.1911, Das 34978 (CAL).

NAGALAND: Naga hills, Dent 366 (DD).

ORISSA: Balitakudar, Bonai, 3.6.1950, Mooney 3811 (DD);  
Tirarapara, along a stream, Raju 1949 (CAL).

PUNJAB: Gurdaspur, June 1913, Fane 4857 (DD).

SIKKIM: Tista, 22.2.1910, Ribu & Rhomoo 3688 (CAL); Singtam,  
16.5.1967, Pal 344 (CAL).

TAMIL NADU: Tirunelveli, Courtallum, 24.6.1901, Barber 3261  
(MH); Coimbatore, Anamalai hills, palkadavu, 8.5.1915,  
Fischer 3811 (CAL); Nilgiri, Kulivayal R.F., 960 m,  
25.7.1972, Vajravelu 41817 (MH).

TRIPURA: Agartala, 150-240 m, 3.3.1916, Debbarman 1053 (CAL); Agartala, 6.7.1956, Deb 347 (CAL); Bagapasha, 28.8.1957, Deb 7065 (CAL); North Radha-Kishore pore, 28.8.1957, Rao 8921 (CAL).

UTTAR PRADESH: Dehra Dun, Chandbagh, 16.8.1920, Gupta s.n. (DD); Kumaon, Tanakpur, 14.5.1961, Bhattacharya 15239 (BSD); Gorakhpur, 1.11.1963, Arora 1425 (CAL).

WEST BENGAL: Jalpaiguri, Khuntimari, 25.5.1944, Mukherjee 970 (DD); Jalpaiguri, 14.5.1949, Narayanaswamy 2409 (CAL); Howrah, Domjoor, 10.5.1963, Bennet 238 (CAL); Bhadrasawar, 21.5.1968, Sen 581 (CAL); Birbhum, Santiniketan, 24.2.1986, Biswas 19469 (CAL).

### 3. LAWSONIA

*Lawsonia* L., Sp. Pl. 349. 1753; Gen. Pl. ed. 5: 166. 1754; DC Prod. 3: 90. 1828; Roxb., Fl. Ind. (ed. Carey) 2: 258. 1834; Endl. Gen. 1202. 1840; Hook. f. in Benth & Hook., Gen. Pl. 1: 782. 1867; Baill., Hist. Pl. 6: 433. 1877; Clarke in Hook. f., Fl. Brit. India 2: 573. 1879; Koehne in Engl., Bot. Jahrb. 4: 36. 1883 & in Engl., Pflanzenr. 17 (4, 216); 270. 1903; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan 78: 5. 1975.

Lausonia Juss. Gen. Pl. 331. 1789.

Type : Lawsonia inermis L., Sp. Pl. 349. 1753.

Shrub, glabrous, branched; branchlets spine-tipped. Leaves opposite, decussate, entire, petiolate. Inflorescence a terminal panicle. Flowers small, 4-merous, pedicellate; bracts small caducous. Calyx tube cup-shaped, shorter than calyx lobes; lobes 4, accessory teeth absent. Petals 4, orbicular or obovate, crumpled. Stamens 8, inserted in pairs, episepalous, exserted. Ovary subglobose, 4-locular. Capsule globose, irregularly dehiscent or indehiscent, well exceeding calyx tube. Seeds numerous, pyramidal, non-winged.

A monotypic genus, possibly of African origin, but widely cultivated for centuries throughout the old world tropics and subtropics as a source of the red dye henna and for its fragrant showy inflorescences. Floral morphology and anatomy place Lawsonia closest to but less advanced than Lagerstroemia.

Chromosome number:  $n = 12, 15$  occur in the genus (Tobe et al., 1986).

Palynology: Pollen prolate, and circular; tricolporate with 6 pseudocolpi, colpi meridionally elongated, equatorially arranged, equidistant, straight, c. 11-13  $\mu\text{m}$  long, extending within 3-4  $\mu\text{m}$  of pole, P/E 1.3, margin entire sides parallel, apices rounded, narrow costae colpi c. 1.5  $\mu\text{m}$  wide, pseudocolpi shorter (8-10  $\mu\text{m}$ ), distinctly granular, otherwise like colpi, pore circular to slightly elongated equatorially, diameter 2-3  $\mu\text{m}$ , situated at midpoint of colpus, margin entire, narrow annulus c. 1  $\mu\text{m}$  wide; wall 1-1.5  $\mu\text{m}$  thick, psilate; tectate; 20-25 p x 15-17 E  $\mu\text{m}$ .

**Lawsonia inermis** L., Sp. Pl. 349, 1753; Roxb., Fl. Ind. 2: 258. 1832 Koehne in Engl., Bot. Jahrb 4: 36. 1883 & in Engl., Pflanzenr. 17(4, 216): 270. 1903; Cook, Fl. Pres. Bombay 1: 511. 1903; Gamble, Fl. Pres. Madras 1: 514. 1919; Haines, Bot. Bihar & Orissa 374. 1922. Iqbal Dar in Nasir & Ali, Fl. W. Pakistann 78: 5. 1975.

L. spinosa L. Sp. Pl. 349. 1753.

L. alba Lam., Encycl. Meth. Bot. 3: 106. 1789; DC., Prod. 3: 91. 1828; Wight & Arn., Prod. Ind. Or. 1: 307. 1834 & Ill. Ind. Bot. 1: t. 87. 1840; Clarke in Hook. f., Fl. Brit. India 2: 573. 1879; Trimen, Fl. Ceylon 2: 288.

1894; Duthie, Fl. Upper Gang. Plain. 1: 353. 1903; Prain, Bengal Pls. 1: 502. 1903; Brandis, Ind. Trees. 340. 1911.

Type: Herb. Linn. 496/1 (LINN; microfische CAL\*)

Local names: Mehndi (Beng., Hind.); Gorantu (Kan.) Mayilanchi (Mal.) Mendhi (Mar.); Marithondi (Tam.); Gorinta (Tel.).

Shrubs upto 4 m tall; branchlets spinous at tip. Leaves 2-4 x 1.5-2 cm, elliptic, lanceolate or oblanceolate, attenuate at base, acute at apex, subsessile. Panicles 3-20 cm long, terminal, cymose. Flowers c. 5 mm across, pedicellate, 4-merous. Calyx tube c. 2 mm long, cup shaped, lobes 4, 2-3 mm long ovate, acute, persistent. Petals 4, 3-4 x 4-5 mm orbicular or obovate, yellowish, crumpled. Stamens 8, inserted in pairs on rim of calyx tube. Ovary globose, 4-celled; style 3.5-5 mm long, erect; stigma cupitate. Capsule 6-9 mm across, globose, exceeding calyx-tube, irregularly dehiscent; seeds many, pyramidal, c. 3 mm long, turbinate.

Fls. & Frts. : January - August.

Distribution: Throughout India; Throughout tropical Africa, Asia and Australia.

Uses: Leaves possess antimicrobial activity. Leaves yield brownish red dye which is largely used in India for dyeing nails, skin and feet. Essential oil from flowers used in perfumery.

Specimens examined:

ANDHRA PRADESH: Nellore, Ramapatam, July 1883, Gamble 12243 (DD); Nellore Sriharikota, February 1889, Gamble 20393 (MH); Nellore, Allum, 17.7.1907, Barber 7930 (MH); Cuddapah, Motakatla tank, 550 m, 28.2.1959, Subramanyam 7822 (MH); Medak, Narsapur, 700 m, 23.4.1959, Sebastine 7962 (MH); Karimnagar, Aklarpur, 200 m, 24.9.1965, Subbarao 25653 (MH); Anantapur, 350 m 21.2.1983, Yesoda 999 (MH).

BIHAR: Chota Nagpur, 1873, Wood s.n. (CAL); Santhal pargana, May 1901, Harsukh 514 (DD); Palamou, 28.11.1906, Haines 2336 (DD); Silingi, Bonsbi river, 21.12.1957, Panigrahi 12073 (CAL).

KARNATAKA: Shimoga, 600-900 m, October 1908, Meebold 6824 (CAL); South Kanara forest division, 7.12.1957, Sethe & Nage 25635 (DD).

KERALA: Quilon, 20.3.1894, Bourdillon 135 (CAL, MH);  
 Trichur, Wadakanchery, 7.9.1976, Ramamurthy 47699 (MH);  
 Palghat, Thenkara, 300 m, 13.10.1979, Nair 64606 (MH);  
 Cannanore, Kannothe R.F., 125 m, 19.4.1980. Ramachandran  
 66907 (MH).

MADHYA PRADESH: Jabbalpore, Umaria village, 16.8.1949,  
NarayanaSwami 3104 (CAL); Rewa, 22.4.1960, Sebastine  
 10007 (MH); Hoshangabad, Banglapore, 356 m, 23.4.1961,  
Joseph 12402 (MH); Mandla, 500 m, 7.4.1962, Joseph  
 14030 (MH).

MAHARASHTRA: Nagpur, Stewart 19392 (DD).

ORISSA: Ganjam, Chatrapur, April 1904, Fischer & Gage s.n.  
 (CAL, MH).

PUNJAB: Without locality, Aitchinson 144 (DD).

RAJASTAN: Jaisalmer, Amarsagar, 4.9.1964, Wadhwa 5209 (CAL);  
 Jhalawar, Manoharthana, 26.4.1964, Verma 3458 (CAL).

TAMIL NADU: Chidambarnar, Tuticorin, February 1882, Brandis  
 s.n. (CAL); Nilgiris, 1891, Schmid s.n. (CAL);  
 Kamalapore, September 1910, Meebold 11208 (CAL); Salem,  
 Hoganakkal, 11.2.1927, Jacob 77446 (MH); Ramnad-  
 hapuram, Palayampatti, 12.3.1953, Maduram 21894 (MH);



Tirunelveli, Tiger falls, way to Manchola, 300 m, 30.6.1957, Sebastine 3731 (MH); Thiruchirappalli, Sambari, near Varichettipalayam, 233 m, 12.8.1958, Sebastine 6289 (MH); Thanjavur, Pattukkotai to Vadasserai, 50 m, 16.9.1977, Ramamurthy 51278 (MH).

TRIPURA: Agartala, 250-300 m, 30.9.1914, Debbarman 116 (CAL).

UTTAR PRADESH: Kheri, Dudhia, 12.5.1895, Inayat 21579 (DD); Gonda, Narhema, 30.5.1895, Harsukh 21578 (CAL, DD); Dehra Dun, September 1896, Mackinnon s.n. (CAL); Banda, 11.11.1957, Rao 3652 (BSD); Mirzapur, T. falls, 8.2.1961, Battacharya 13244 (BSD).

WEST BENGAL: Lower Bengal, May 1867, Kurz s.n. (CAL); Birbhum, Santiniketan, 28.1.1956, Mukherjee 4133 (CAL); Howrah, Kalgachia, 12.5.1963, Bennet 305 (CAL).

ANDAMAN & NICOBAR ISLANDS: Andamans, 15.11.1889, Prain s.n. (CAL); South Andaman, 1890, King s.n. (CAL); Middle Andamans, Mayabunder, 1.8.1974; Bhargava 1987 (CAL).

LAKSHADWEEP ISLANDS: Kavarathi, 20.2.1959, Srinivasan 1787 (CAL).

## 4. LYTHRUM

*Lythrum* L., Sp. Pl. 446. 1753; Gen. Pl. ed. 5. 205. 1754;  
Willd., Sp. Pl. 2: 866. 1799; DC., Prod. 3: 80. 1828;  
Endl., Gen. 200. 1840; Hook. f. in Benth. & Hook. f.,  
Gen. Pl. 1: 779. 1867; Baill., Hist. Pl. 6: 426. 1877;  
Koehne in Engl., Bot. Jahrb. 1: 305. 1881 & in Engl.,  
Pflanzenr. 17( 4, 216): 58. 1903; Iqbal Dar in Nasir &  
Ali, Fl. W. Pakistan 78: 5. 1975.

Salicaria (Tourn) Adans, Fam. 2: 234. 1763; Tourn ex Mill.,  
Gard. Bot. 2: 108. 1780.

Bergenia Neck., Elem. Bot. 2: 108. 1780.

Mozula Raf., J. Phys. 96. 1819.

Type: L. Salicaria L., Sp. Pl. 446. 1753 (Lectotype  
species selected by Britton & Brown, Ill. Fl. Nor. Eas. Uni.  
Sta. ed. 2. 2: 580. 1913).

Annual or perennial herbs or subshrubs of moist  
habitats, glabrescent to tomentose. Leaves membranous,  
decussate, alternate or often verticillate, ovate to linear,  
sessile or subsessile, attenuate to cordate at base.  
Flowers regular, (4-) 6-merous, sometimes heteromorphic with  
2 or 3 floral forms, axillary solitary or in pairs at a node

or in terminal spikes or racemes, sessile or shortly pedicellate. Bracteoles 2, linear, opposite. Calyx tube cylindrical, greenish, 4-8 mm long, 8-12 nerved, lobes (4-) 6, triangular, acute to acuminate at apex; calyx appendages as many as calyx lobes, alternating with them, narrowly triangular, shorter than to exceeding the calyx lobes. Petals (4-) 6, inserted at the top of calyx tube, rose-purple or white, caducous. Stamens 4-12, in 1 or 2 whorls, inserted deep in the calyx tube; anthers included to exserted; filaments in heteromorphic forms in 2 or 3 lengths. Ovary sessile or stipitate, ellipsoidal or subcylindrical, 2-locular; style simple, thin, in heteromorphic forms in 2 or 3 lengths; stigma capitate, included or exserted. Capsules membranous ellipsoidal or cylindrical, dehiscent by 2-valves. Seeds many, small, triangular, obovate.

A genus of primarily Eurasian and North American distribution, represented by about 35 species. In India the genus is represented by 2 species, both of which are confined to North West Himalayas. It best known by L. salicaria, loosestrife, a trimorphic species whose pollination and breeding mechanisms were the basis for the first extensive account of heterostyly (Darwin 1865, 1877).

Chromosome numbers:  $n = 5, 10, 15, 25$  and  $30$  have been reported for the genus (Tobe et al., 1986).

Palynology: Pollen oblate-spheroidal to prolate-spheroidal, amb circular to lobate; tricolporate with 3 pseudocolpi (heterocolpate), colpi meridionally elongated, equatorially arranged, equidistant, straight, c.  $18-26\ \mu\text{m}$  long, extending within  $3-5\ \mu\text{m}$  of pole, P/E  $0.5$ , margin entire, tapering to acute apex, narrow costate colpi c.  $1-1.5\ \mu\text{m}$  wide, granular membrane, pseudocolpi shorter ( $14-20\ \mu\text{m}$ ), otherwise like colpi, pore circular, relatively large and conspicuous (diameter  $2.5-4\ \mu\text{m}$ ), situated at midpoint of colpus, margin entire, annulus c.  $1\ \mu\text{m}$  wide, slightly protruding with granulations frequently evident on flanks of annulus; wall  $1.5\ \mu\text{m}$ , striate, striae arranged parallel to colpi (viz., pole to pole); tectate;  $18-26$  to  $40-48\ \mu\text{m}$ . (Graham et al., 1987).

#### Key to the species

- 1a. Flowers monomorphic, solitary  
in axils of floral leaves;  
stamens 4-6, all included. .... L. tribracteatum 2

- lb. Flowers trimorphic forming  
 spicate inflorescence; stamens  
 12, some or all exserted. .... L. salicaria 1

1. Lythrum salicaria L., Sp. Pl. 446. 1753; Koehne, Bot. Jahrb. 1: 326. 1881 & in Engl., Pflanzenr. 17(4, 216): 73 1903; Kitamura in Fl. Afganistan 277. 1960; Webb. in Tutin et al. Fl. Europea 2: 301. 1968; Chamberlain in Davis, Fl. Turkey 4: 175. 1972; Stewart, Annot. Cat. Vasc. Pl. W. Pak & Kashmir 500. 1972; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan No.78: 7. 1975; Chowdhery & Wadhwa, Fl. Himachal Pradesh 1: 290. 1984; Polunin & Stainton, Flow. Himal. 147. 1984.

L. tomentosum Mill., Gard. Dict. ed. 8(2): 1768; DC., Catal. Hort. Monsp. 123. 1813.

L. salicaria L. var. tomentosum (Mill.) DC., Prod. 3: 83. 1828; Koehne in Engl., Bot. Jahrb. 1: 329. 1881.

L. intermedium Ledeb., Ind. Sem. Hort. Dorpat. Mose. 92. 1838; Murav'eva in Fl. USSR 15: 413. 1986 (Repd. ed.).

L. cashmerianum Royle, Ill. Bot. Himal. 203. 1839.

Type: Described from Europe, Savage Cat. No. 625/1 (LINN; Microfische CAL\*).

Perennial herbs or subshrubs. Stem 30-150 cm long, simple or branched, ribbed, glabrous to tomentose, woody. Leaves sessile, upper alternate, lower opposite, 3-7 x 0.5-2 cm, ovate to linear-lanceolate, cordate or rounded at base, acuminate at apex, puberulous on both sides or rarely glabrous. Spike 10-65 cm long, terminal, simple or branched. Flowers clustered in axils of bracts; pedicel 1-2 cm long; bracts 5-40 x 2-8 mm, ovate to linear-lanceolate, base cordate, acuminate at apex; bracteoles 2, linear, equalling to or half as long as calyx tube, margins ciliate. Calyx tube cylindrical or tubular-campanulate, 5-7 x 2-3 mm, 12-ribbed, glabrous or tomentose, sometimes hairy only on ribs, lobes 6, 0.75-1 mm long, triangular, acuminate at apex, margins ciliate; appendages 6, 1.5-2 mm long, subulate, ciliate at apex or rarely fully. Petals 6, 6-9 x 2-4 mm, oblong or obovate-lanceolate, obtuse at apex, cuneate at base, inserted at the top of calyx tube, purple. Stamens 12, dimorphic; filaments of episepalous stamens, long and exserted c. 7 mm; filaments of epipetalous stamens, short and included, c. 3.5 mm; anthers dimorphic, those of long stamens 0.5 x 0.4 mm and those on short stamens 0.3 x 0.25 mm; ovary c. 2.5 x 1 mm, ellipsoid, bilocular; style simple, of different lengths, in short-styled flowers upto 1 mm long, in medium-styled flowers upto 5 mm long and in long-styled flowers upto 8 mm long; stigma capitate.

Capsule c. 3-4 x 2 mm, ovoid or ellipsoidal, 2-valved, included in the calyx tube. Seeds many, obovate(Text Fig.7).

Distribution: INDIA: Kashmir, Himachal Pradesh; EUROPE; USSR; IRAN; TURKEY; AFGANISTAN; PAKISTAN; JAPAN; CHINA; KOREA; TIBET; NORTH AMERICA; NORTH AFRICA; AUSTRALIA(Map 6).

Ecology: In India it occurs in river banks, lake shores and other marshy places of W. Himalayas upto 2100 m altitude.

Fls. & Frts. July-September.

Specimens examined:

HIMACHAL PRADESH: Kulu, Sultanpur, August, 1864, Brandis 3206 (CAL, DD); Kulu, Banjoura, 12.10.1886, Collet s.n. (CAL), Kulu, Banks of Beas, Watt 13448 (CAL, BSIS); Kangra, Banjar, 28.9.1936, Parker 3361 (DD); Lahul, Keylong, 13.7.38, Bor s.n. (DD); Kulu, 30.9.1984, Srivastava 76157 (BSD).

JAMMU & KASHMIR: Kashmir, Thomson s.n. (CAL); Kashmir, Falconer 454 (CAL); Anchar lake, 1610 m, 6.7.1891, Gammie s.n. (CAL, DD); Ladakh valley, Bawan, 1.8.1901,

Text Fig. 7. Lythrum salicaria L.

a. Habit

b. Flower





Text Fig. 7

Inayat 25615 (DD); Jhelum valley, Banirpur, 1600-1675 m, 22.8.1909, Keshavanand 1382 (DD); Pastun Tral range, 1765 m, 18.8.1927, Lambart 192 (DD); Harwan Reserve Forest, 2100 m, 28.7.1956, Rao 844 (CAL, BSD); Srinagar, Dal lake, 1735 m, 15.9.1958, Rao 7732 (BSD); Way to Nagin lake, 18.9.1960, Malhotra 12277 (BSD).

2. *Lythrum tribracteatum* Salzm. ex Spreng., Syst. Veg. 4(2): 190. 1827; Koehne, Bot. Jahrb. 1: 312. 1881 & in Engl. Pflanzenr. 17(4, 216): 64. 1903; excl. var. condolei Koehne; Kitamura in Fl. Afganistan 278. 1960; Webb, in Fl. Europea 2: 301. 1968.

L. bibracteatum Salzm. ex DC., Prod. 3: 81. 1828.

Type: Described from France, Ager Monspeliensis 1827, Salzmann (K).

Glabrous erect, herbs, c. 25 cm long. Stem branched, terete below, 4-angled above; angles scabrous. Leaves simple, sessile alternate, 6-12 x 1-2 mm, linear, rarely oblanceolate, attenuate at base, obtuse at apex, margin and midribs scabrous beneath. Flowers solitary, axillary, short pedicelled; pedicel c. 0.5 mm; bracteoles 2, c. 0.5 mm long,

linear eciliate. Calyx c. 5.5 x 0.5-1 mm, narrowly cylindrical, 12-nerved, lobes 6, c. 0.5 mm long, triangular; appendages 6, narrower, as long as lobes. Petals 6, c. 2 x 0.5 mm, oblong, attenuate at apex. Stamens 4-6, inserted in the calyx tube at different levels; filaments of the lower stamens c. 2 mm long, filaments of the upper stamens c. 1 mm long. Ovary 3-3.5 x 0.25-0.3 mm, cylindrical; style 2-2.5 mm long; stigma capitate. Capsules c. 4 x 1 mm, narrowly cylindrical, included in calyx tube. Seeds c. 0.5 mm, triangular, numerous. (Text Fig. 8).

Distribution: INDIA: Kashmir; EUROPE; USSR; IRAN; TURKEY; AFGANISTAN. (Map 6).

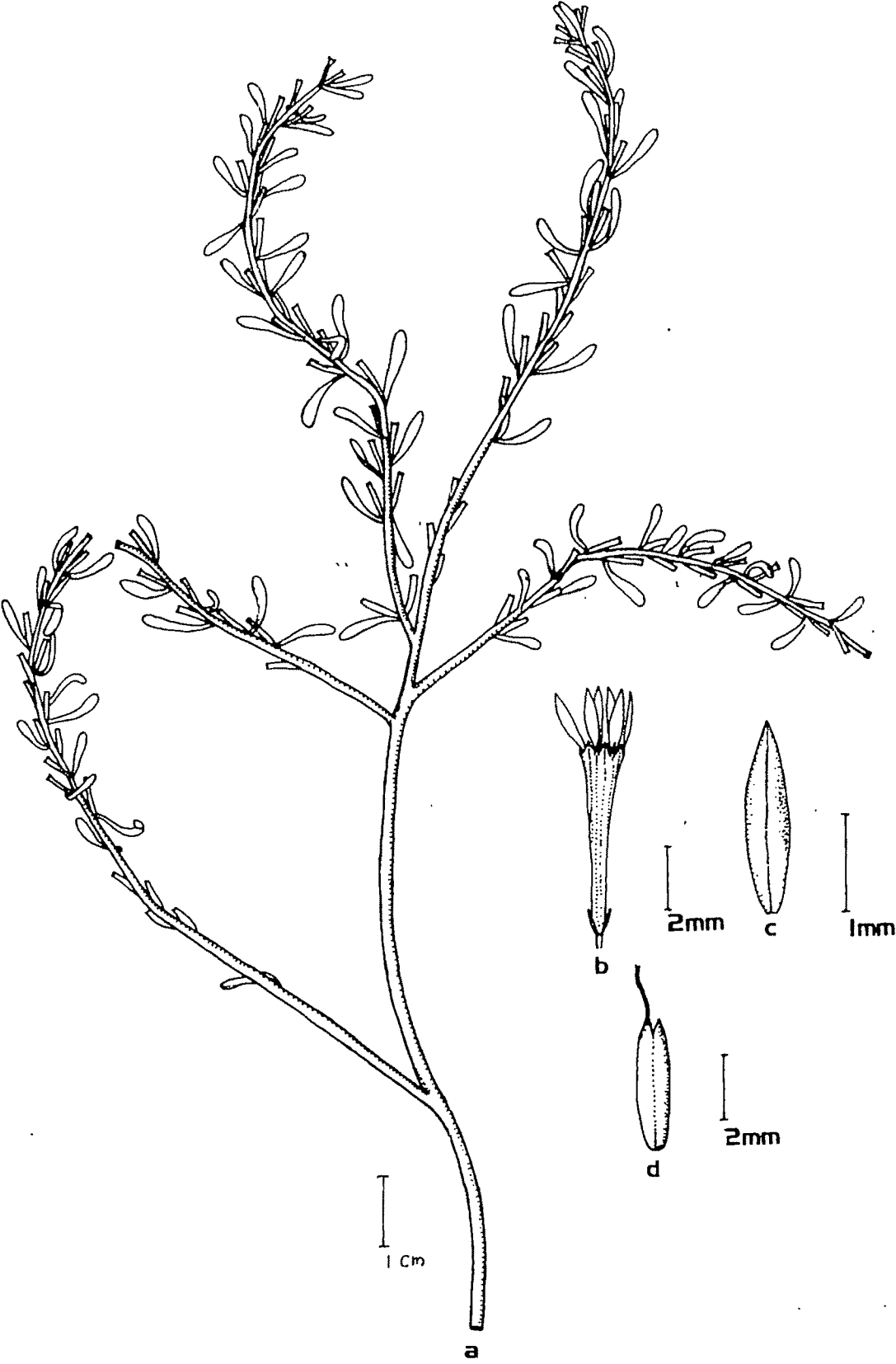
Notes: This is the first record of this species from India. The plant was collected from Baramula in north-west Himalaya at 1200 m altitude by A. Meebold (1905). He identified it as L. tribracteatum and mentioned in the herbarium sheet as "new to India".

Specimen examined:

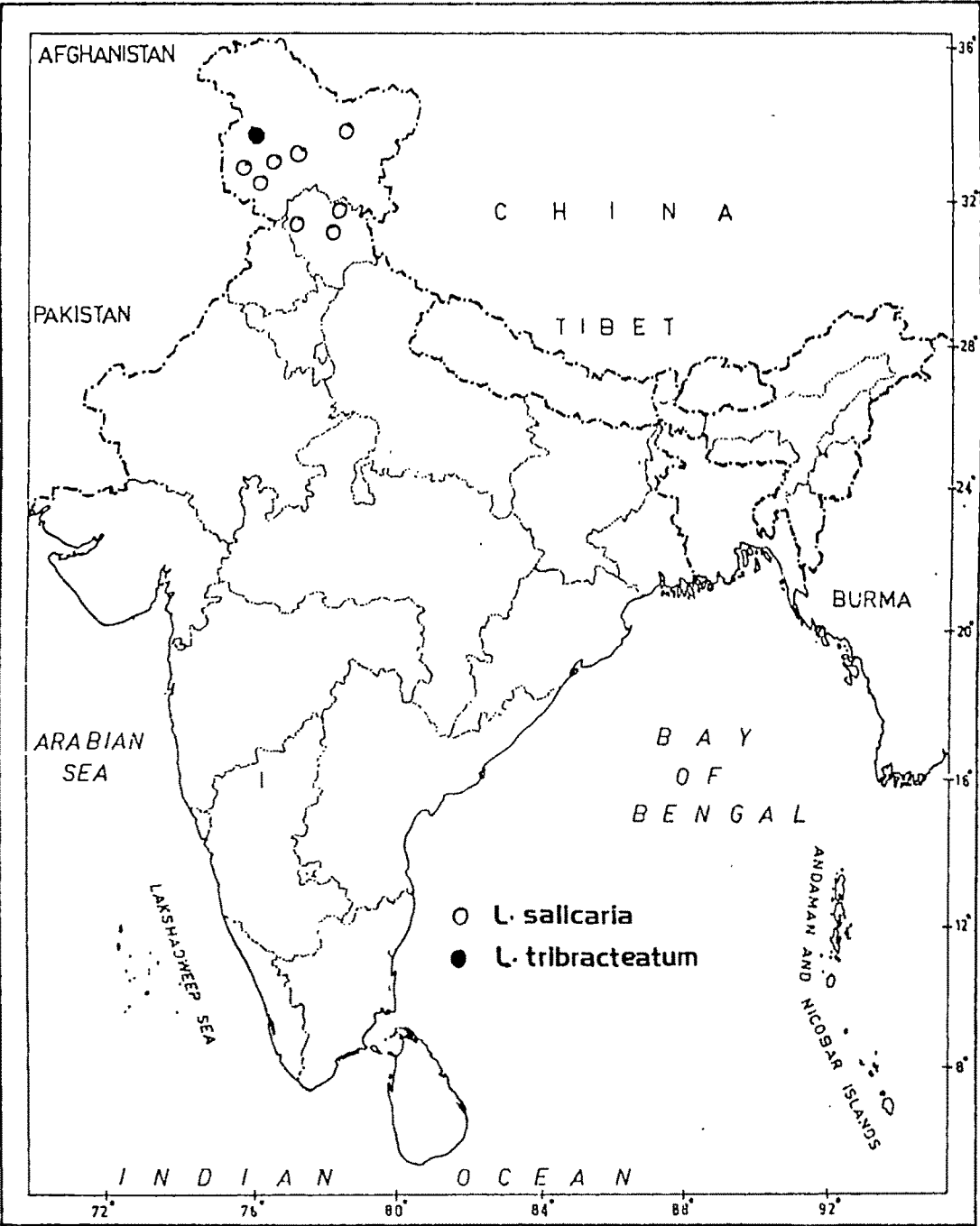
JAMMU & KASHMIR: Baramula, 1200 m, September 1905, Meebold 4620 (CAL).

Text Fig. 8. Lythrum tribracteatum Salzm. ex Spreng.

- a. Habit
- b. Flower
- c. Petal
- d. Capsule split open



Text Fig. 8



Map 6. Distribution of *Lythrum salicaria* and *L. tribracteatum* in India.

## 5. NESAEA

*Nesaea* Comm. ex Kunth in H.B.K. Nov. Gen. Sp. 6: 191. 1823;  
 DC., Prodr. 3: 90. 1828; Koehne in Engl., Bot. Jahrb.  
 3: 321. 1882 & in Engl. Pflanzenr. 17(4, 216): 221.  
 1903; Panigrahi, Bull. Bot. Surv. India 18: 1901. 1976.

Lythrum L.f., Suppl. 249. 1781. p.p.

Ammannia DC., Mem. Soc. Phys. Geneve 3(2): 89. 1826 & Prod.  
 3: 77. 1828 p.p.; Wight & Arn., Prod. Fl. Ind. Or. 304.  
 1834 p.p. , Thwaites, Enum. Zeyl. 121. 1864. p.p.

Nesaea sect. Nesaea St. Hil., Fl. Brasil. 3: 138. 1833;  
 Endl. Gen. 1200. 1840; Hook. f. in Benth. & Hook. f.,  
 Gen. Pl. 1: 779. 1867.

Nesaea sect. Eunesaea Baill., Hist. Pl. 6: 424. 1877.

Ammannia subgenus Eu-Ammannia Clarke in Hook.f., Fl. Brit.  
 India 2: 569. 1879 p.p.

Type: Nesaea triflora (L.f.) Comm. ex Kunth in H.B.K.,  
 Nov. Gen. Sp. 6: 191. 1824.

Annual or perennial, glabrous, rarely pubescent herbs.  
 Stems often tetragonous. Leaves sessile, decussate, rarely  
 alternate or whorled. Inflorescences axillary sessile,

subsessile or pedunculate, dichasial cymes or rarely solitary. Flowers actinomorphic, subsessile or pedunculate; bracteoles 2. Calyx tube campanulate, urn-shaped or globose, herbaceous, glabrous or pubescent; calyx lobes 4-8; appendages long, short or absent. Petals 0-8, corrugated in bud, ovate or obovate or suborbicular. Stamens 4-many, episepalous, included or exserted. Ovary sessile, 2-5 celled, globose, included, septum complete; the placenta therefore continuous with the style; style absent or short or long and exserted; stigma capitate. Capsules globose or ellipsoid, included or exserted, circumscissile dehiscent. Seeds numerous, minute, flattened or hollowed on one side and round or convex on the outer side, 0.45-0.55 mm long.

Distribution: A genus of about 50 species distributed in AFRICA, MADAGASCAR, INDIA, SRI LANKA, AUSTRALIA, U.S.A. and MEXICO. Majority of the species ie. 46 species occur in Africa, and three species each occur in Ausutralia, Sri Lanka, India, U.S.A. and Mexico.

Chromosome numbers:  $2n = 50$  and  $60$  have been reported (Tobe et al., 1986).

Palynology: Pollen prolate to prolate-spheroidal, amb circular (lobate due to mesocolpial ridges and pseudocolpi);



tricolpate with 6 pseudocolpi (heterocolpate), colpi meridionally elongated, equatorially arranged, equidistant, straight, c. 24-28  $\mu\text{m}$  long, extending within 3-6  $\mu\text{m}$  of pole (PI 0.11), P/E 1.2, margin entire to minutely dentate, gradually tapering to acute apex to frequently more rounded, narrow costae colpi c. 1.5  $\mu\text{m}$  wide, membrane sparsely to more distinctly granular, pseudocolpi slightly shorter (18-22  $\mu\text{m}$ ), otherwise like colpi; pore circular, relatively large and conspicuous (diameter 3.5-4.5  $\mu\text{m}$ ), situated at midpoint of colpus, margin entire, narrow annulus c. 1  $\mu\text{m}$  wide; wall 1.5  $\mu\text{m}$  thick, slightly thicker in mesocolpial region, forming faint ridges that fuse at poles, striate, striae generally arranged parallel to colpi or occasionally irregularly oriented; tectate; 26-38 P x 20-32 E  $\mu\text{m}$  (Graham et al., 1987).

Key to the species

- 1a. Cymes distinctly pedunculate,  
 c. 2.5 cm long; stamens twice  
 as many as the number of  
 calyx lobes; anthers and  
 stigmas exserted ..... N. triflora 3

- 1b. Cymes sessile or subsessile;  
stamens as many as the number  
of calyx lobes; anthers and  
stigmas included:
- 2a. Leaves attenuate or cuneate at  
base; calyx lobes 0.5 mm or  
less, subrounded and apiculate;  
petals present ..... N. <sup>N</sup>laceolata 2
- 2b. Leaves cordate at base; calyx  
lobes 0.75-1 mm long, trian-  
gular and acute; petals  
absent ..... N. brevipes 1

1. *Nesaea brevipes* Koehne in Engl., Bot. Jahrb. 3: 326. 1882  
& in Engl., Pflanzenr. 17 (4, 216): 226. 1903; Blatt. &  
Hallb., J. Bombay Nat. Hist. Soc. 26: 217. 1918;  
Gamble, Fl. Press. Madras 1: 510. 1919; Sen, Bull. Bot.  
Soc. Bengal 33: 36. 1979; Matthew & Britto in Matthew,  
Fl. Tam. Carnatic 3: 610. 1983; Ramachandran & Nair,  
Fl. Cannanore 193. 1988.

Ammannia cordata Wight & Arn., Prod. Fl. Ind. Or. 304. 1834;  
 Clarke in Hook. f., Fl. Brit. India 2: 570. 1879;  
 Trimen, Fl. Ceylon 2: 225. 1894; Prain, Bengal Pls. 1:  
 501. 1903.

Ammannia salicifolia var. B Thwaites, Enum. Pl. Zeyl. 121.  
 1894 (non Monti, 1767).

Type: India, Coimbatore, among bushes in moist soil,  
Wight in Wall. Cat. No. 6322 (Lectotype CAL, selected here  
 as lectotype; Iso. K-W); Pen. Ind. Or., Herb. Wight prop  
 1021 (syntype: K; photo. CAL).

Annual, erect or decumbant, herbs. Stems 8-40 cm high,  
 simple or branched, stem apices and branches quadrangular.  
 Leaves 10-45 x 2.5-18 mm, elliptic, oblong or ovate, rarely  
 lanceolate, obtuse or cordate at base, rarely lower few  
 cuneate, acute or obtuse at apex, margin cartilaginous.  
 Inflorescences axillary, sessile or subsessile, cymes.  
 Flowers subsessile, 1-3(-5) per cyme; pedicels, c. 0.5 mm or  
 less; bracteoles 2, 2-4 mm long, as long as calyx,  
 lanceolate. Calyx tube 1.5-3 mm long, campanulate, glabrous,  
 8-nerved; calyx lobes 4, 0.75-1 mm long, triangular, acute;  
 appendages 4, half the length of calyx lobes, apex ciliated.  
 Petals absent. Stamens 4, inserted near the base of calyx

tube; anthers included. Ovary c. 1 x 1 mm sessile, globose, 2-loculed; style very short or inconspicuous; stigma capitate, included. Capsules 1.5-2 mm across, subglobose or globose, fully covered by calyx lobes. Seeds many, 0.2-0.5 mm long, suborbicular (Fig.7).

Fls. & Frts. : September-March.

Distribution: INDIA: West Bengal, Orissa, Madhya Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala; SRI LANKA; BANGLADESH (Map 7).

Notes: (1) Koehne (1880) published N. brevipes as nomen. nova, based on Ammannia cordata Wight & Arn. While describing A. cordata, Wight and Arnott did not designate any types, but they had mentioned two collections "Wall. Cat. no. 6322 and Wight Cat. no. 1021". After studying the original materials, the present author selected the collection Wight in Wall. Cat. no. 6322, collected from Coimbatore, among moist soil, 31 October 1827, and deposited in CAL as the lectotype of Nesaea brevipes Koehne.

(2): Wight and Arnott in their description of Ammannia cordata, mentioned that "petals 4, obovate". The present author examined many specimens, including type specimens, and found no petals.

Fig. 7. Type photograph of Nesaea brevipes Koehne



BSIN 5839

8322 *Ammannia cordata* Wight. & A. Wight  
(lost spec 2095-2107)

Herb. Wight. propr.



Peninsula Ind. orientalis.

1021 *Ammannia cordata* Wight. & A. Wight

FLORA OF INDIA

Det. J. B. Gamble

1915

*Ammannia cordata* Wight.

FLORA BRIT. INDIA. II. 570  
Named by Mr. C. B. CLARKE.

7

Specimens examined:

ANDHRA PRADESH: Cuddapah, Balapalle, 250 m, 21-2-1963, Ellis 15729 (CAL, MH).

KERALA: Kasaargod, Sea level, 13..1945, Rao & Raju 88238 (MH).

MADHYA PRADESH: Chandah (Khandwa), 28-12-1889, Duthie 9484 (CAL, DD); Cannanore, Tolpetty Reserve Forest, 775 m, Ramachandran 52394 (MH).

ORISSA: Ganjam, Kaliambra, 300 m, February 1884, Gamble 13838 (CAL, MH); Ganjam, Chatrapur, December 1889, Gamble 21543 (DD), Panasaputta, 19-12-1962, Rao 30375 (CAL).

TAMIL NADU: Coimbatore, 31.10.1827, Wight in Wall. Cat. 6322 (CAL); Tirunelveli, Courtallum, April 1835, Wight 273 (CAL); Tirunelveli, Mundanthurai, 225 m, 19.2.1913, Hooper & Ramaswami 39299 (CAL); Vandalur, February 1941, Barnes s.n. (DD); Madurai, Alagar Hills, Nupura sanga, 267 m, 11.6.1957, Subramanyam 3410 (MH); Thirunelveli, Mundanthurai, 225 m, 22.2.1960, Sebastine 9907 (CAL); Chingalput, Vedanthangal, 26.12.1976,

Henry 47051 (CAL, MH); South Arcot, Gingee, Kawai R.F.,  
150 m, 20.1.1978, Ramamurthy 52860 (CAL).

2. *Nesaea lanceolata* (Heyne ex Clarke) Koehne in Engl., Bot.  
Jahrb 3: 325. 1882 & in Engl., Pflanzenr. 17 (4, 216):  
226. 1903; Blatt. & Hallb., J. Bombay Nat. Hist.  
Soc. 26: 216. 1918; Gamble, Fl. Pres. Madras 1: 510.  
1919; Matthew & Britto in Matthew, Fl. Tam. Carnatic 3:  
610 . 1983.

Ammannia lanceolata Heyne ex Clarke in Hook. f., Fl. Brit.  
India 2: 570. 1879; Trimen, Fl. Ceylon 2: 225. 1894.

Ammannia verticillata sensu Wight & Arn., Prodr. Fl. Ind.  
Or. 304. 1834 (non Lam., 1783).

Ammannia salicifolia sensu Thwaites, Enum. Pl. Zeyl. 121.  
1894 p.p. (non Monti, 1767).

Type: Ceylon, Thwaites 2796 (Lectotype BM; Photo.  
CAL).

Annual, erect or decumbant herbs. Stem 5-25 cm high,  
simple or branched, stem apices and branches quadrangular.  
Leaves 10-35 x 2-10 mm, oblong, linear-lanceolate or



oblanceolate, attenuate to cuneate or rarely obtuse at base, acute or obtuse at apex, margin cartilaginous, entire or microscopically serrulate. Inflorescences axillary, sessile or subsessile cyme. Flowers subsessile, 1-3 (-5) per cyme; bracteoles 2, 1.5-3 mm long, oblong or linear-lanceolate, midrib prominent, margins toothed or entire. Calyx tube 1.5-3 mm long, campanulate, glabrous or minutely pubescent, 8-nerved; calyx lobes 4 (-5), 0.5 mm or less long, subrotund or widely triangular, apiculate, occasionally margin and apex ciliated; appendages 4, longer or shorter than lobes, subulate, apex ciliated. Petals 4 (-5), c. 1.5 mm long, obovate or suborbicular, pink, caducous. Stamens 4 (-5), inserted at the middle of calyx tube; anthers included. Ovary c. 1 x 0.75 mm, sessile, globose; style very short, less than 0.5 mm; stigma capitate, included. Capsules c. 2.5 x 2 mm, subglobose or globose. Seeds many, c. 0.3 mm long.

Fls. & Frts. : October - March

Ecology: Gregarious herbs growing in coastal plains, banks of ponds, fallow fields and other wet areas, after rainy seasons.

Distribution: INDIA: Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Rajasthan (Parmer 1987); SRILANKA; AUSTRALIA (Map 7).

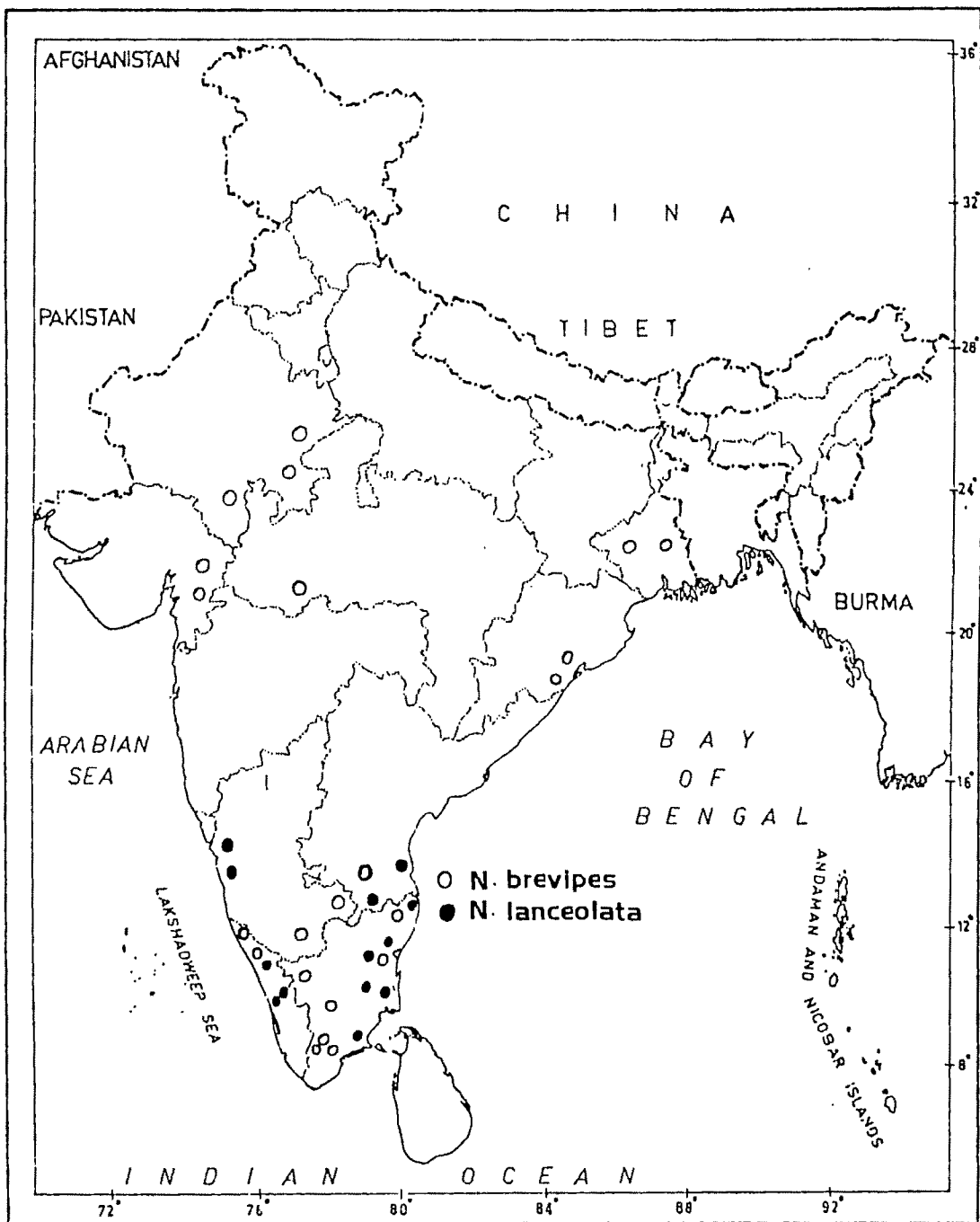
Palynology: P = 18-23  $\mu$ m, E = 10-17  $\mu$ m, P/E ratio = 1.8-2.3; grains, minutae and mediae, spheroid or prolate; pore  $\pm$  circular and plane; amb  $\pm$  triangular; sexine reticulate (Panigrahi, 1979).

Notes: (1) Panigrahi (1976) typified Nesaea lanceolata, by selecting the specimen " Ceylon, Thwaites 2796" (BM) as lectotype.

(2) Nesaea lanceolata is allied to N. brevipes, but is easily recognizable by leaves being attenuate or cuneate at base; presence of petals; calyx lobes 0.5 mm or less, subrotund and apiculate.

Specimens examined:

ANDHRA PRADESH: Nellore, Tada, 16.2.1901, Bourne 2523 (CAL); Chittoor, Chandragiri, 22.2.1914, without collector 9997 (MH).



Map 7. Distribution of *Nesaea brevipes* and *N. lanceolata* in India.

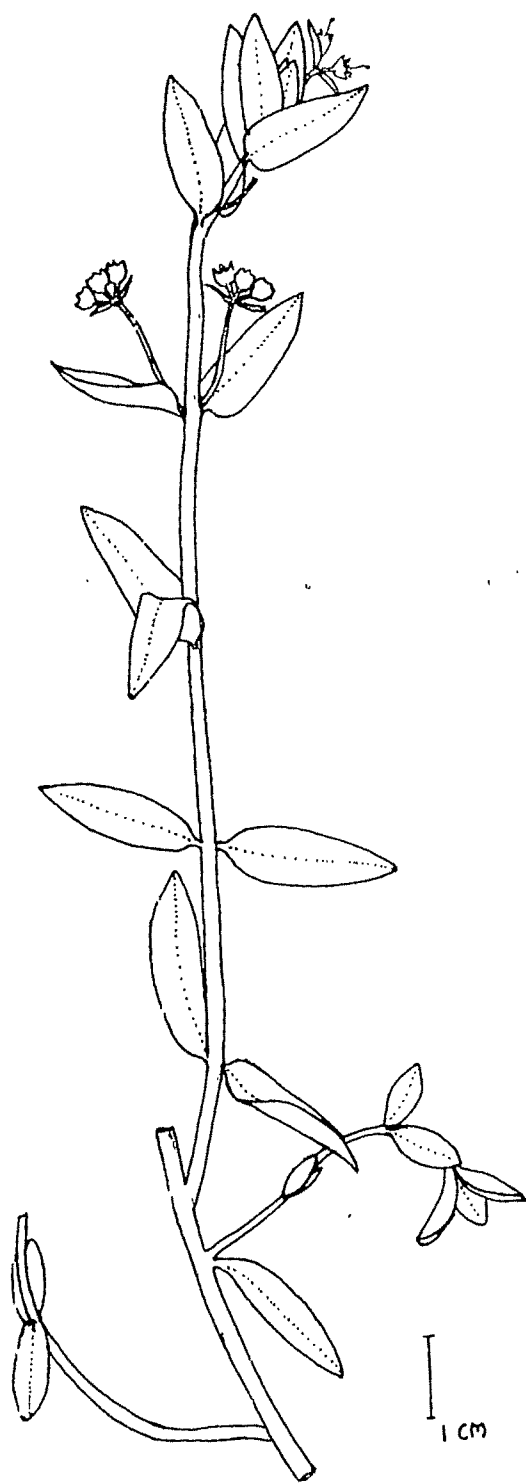
KARNATAKA: North Kanara, Yellapore, October 1882, Talbot s.n.  
(DD) North Kanara, Carwa, 9.10.1887, Talbot 1575 (CAL,  
DD).

KERALA: Trichur, Parambikulam, 14.2.1963, Sebastine 15314  
(MH); Trichur, Guruvayoor, 12.8.1985, Valsa 7127  
(CALI); Malappuram, Olipramkadavu, 15.8.1985, Naseem  
5624 (CALI).

TAMIL NADU: Madras, Adayar, January 1899, Barber 98 (MH);  
Madras, February 1899, Barber 133 (MH); Madras, March  
1899, Barber 226 (MH); Tanjavur, Kodiakadu, 21.1.1961,  
Ellis 11818 (CAL, MH); Ramanathapuram, Sayalkudi,  
8.12.1977, Nair 53194 (CAL, MH); Thiruchirappalli,  
Srirangam Islands, 10.2.1978, Matthew 11779 (CAL);  
South Arcot, Parangipettai, 10.2.1979, Ramamurthy  
58178 (CAL, MH); South Arcot, Tindivanam - Villupuram,  
21.2.1979, Ramamurthy 60362 (CAL).

3. *Nesaea triflora* (L.f) Comm. ex Kunth in H.B.K., Nov. Gen.  
et Sp. Pl. 6: 191. 1824; DC., Prod. 3: 90 1828; Wight,  
Ic. Pl. Ind. Or. 1: t. 259. 1840; Koehne in Engl., Bot.  
Jahrb. 3: 330. 1882 & in Engl., Pflanzenr. 17: 230.  
1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 26:  
218. 1918; Panigrahi, Bull. Bot. Surv. India 13: 186.  
1976.

Text Fig. 9. Habit of Nesaea triflora



Text Fig. 9

Lythrum triflorum L.f., Suppl. 249. 1781.

Ammannia triflora Wall. Cat. No. 6323 nom. nud.

Type: Described from Mauritius (not in LINN).

Annual or perennial glabrous herbs. Stems c. 35 cm long, erect, simple or sparsely branched, tetragonous. Leaves 1.5-3.5 x 0.6-1 cm, sessile or subsessile, oblong or ovate-lanceolate, cuneate or rounded at base, acute or obtuse at apex. Inflorescences axillary, peduncled cymes; peduncles c. 2.5 cm long. Flowers pedicellate, 3-per cyme; pedicels c. 3 mm long; bracteoles 2, c. 4 x 1.5 mm, linear-lanceolate, margin serrulate. Calyx tube c. 2 mm long, subglobose, 8-nerved, lobes 4 or 5, c. 0.75 mm long, broadly triangular, acuminate; appendages c. 0.5 mm, as many as lobes, ciliate. Petals 4 or 5, c. 3.5 x 2.5 mm, obovate. Stamens 8 or 10, inserted below the middle of calyx tube, alternate ones longer, exserted. Ovary c. 1.5 x 1 mm, globose, 3-locular; style c. 3 mm long; stigma capitate, exserted. Capsule c. 3 mm across, globose, completely covered by calyx. Seeds small, numerous. (Text Fig.9).

Distribution: INDIA: West Bengal? (not known whether it was collected from West Bengal or from Bangladesh); SRILANKA; AFRICA; MADAGASCAR; MAURITIUS.

Palynology: P = 21-25  $\mu$ m, E = 12-19  $\mu$ m, P/E ratio = 1.1-2.08; grains minutae, spheroid and prolate; pore projected, rimmed, circular, amb  $\pm$  triangular or angulo-circular; sexine striated, striations short and interrupted. (Panigrahi, 1979).

Notes: The presence of Nesaea triflora in India is documented by a single collection of Walker from Bengal, deposited in Herbarium Kew. The exact locality of this collection is unknown, so it is difficult to ascertain whether it was collected from India or from Bangladesh. The author includes this taxon in the present account due to its doubtful existence in India.

Specimen examined:

WEST BENGAL: Without locality, Walker s.n. (K)

SRILANKA: Ceylon, Walker s.n. (CAL)

## 6. PEMPHIS

Pemphis J.R. & G. Forst., Charact. Gen. Pl. p. 68. t. 34. 1776; DC., Prod. 3. 89. 1828; Wight & Arn., Prod. Fl. Penin. Ind. Or. 307. 1834; Endl., Gen. 1200. 1840;



Hook. f. in Benth. & Hook. f., Gen. Pl. 1: 780. 1867;  
 Baill., Hist. Pl. 6: 434. 1877; Clarke in Hook. f., Fl.  
 Brit. India 2: 573. 1879; Koehne in Engl., Bot. Jahrb  
 3: 132. 1882 & in Engl., Pflanzenr. 17 (4, 216): 185.  
 1903; Brandis, Ind. Trees 339. 1911; Gamble, Fl. Pres.  
 Madras 511. 1919.

Mangium Rumph., Herb. Amb. 3: 126. 1743.

Lythrum L. f., Suppl. 249. 1781 p.p.

Melanium Spreng., Syst. 2: 455. 1825.

Maclellandia Wight, Icon. Pl. Ind. Or. 6: t. 1996. 1853.

Type: Pemphis acidula Forst., Charat. Gen. Pl. p. 68  
 t. 34. 1776.

Shrubs or small to medium sized trees, 5-10 m tall.  
 Leaves opposite, leathery, grey tomentose. Flowers  
 axillary, solitary, pedunculate, bracteolate, 6-merous.  
 Calyx tube campanulate, coriaceous, 12-ribbed, lobes 6.  
 Petals 6, inserted at the top of calyx tube. Stamens 12,  
 biseriate, dimorphic. Ovary sessile, turbinate, 3-locular,  
 many ovuled; style filiform; stigma capitate. Capsules  
 globose, coriaceous, completely covered by calyx tube,  
 circumscissile dehiscent. Seeds many, flat, discoid,  
 angular.

A monotypic genus found mainly on the sea coast and tidal back waters of east Africa, tropical Asia, Pacific islands and Australia. Earlier the genus consisted of two highly disparate species, Pemphis acidula and P. madagascariensis. Graham et al. (1986) removed Pemphis madagascariensis from the genus and described it as a new genus, namely Koehnaria.

Pemphis acidula J.R. & G. Forst., Charat. Gen. Pl. p. 68. t. 34. 1796; Blume, Mus. Lug. - Bat. 2: 128. t. 42. 1856; Clarke in Hook. f., Fl. Brit. India 2: 573. 1879; Koehne in Engl., Bot. Jahrb. 3: 133. 1882 & in Engl., Pflanzenr. 17(4, 216): 185. 1903; Bedd., Fl. Syl. t. 32. 1871; Brandis, Indian Trees 338. 1906; Bourdillon, Forest Trees Trav. 199. 1908; Gamble, Fl. Pres. Madras 1: 511. 1919; Lewis & Rao, Proc. Roy. Soc. Lond. B 178: 79. 1971; Gill & Kyauka, Adansonia 17(2): 139. 1977.

Mangium porcellanicum Rumph., Herb. Amb. 3: 126. 1743.

Lythrum pemphis L.f., Suppl. 249. 1781.

Melanium fruticosum Spreng., Syst, 2: 455. 1825.

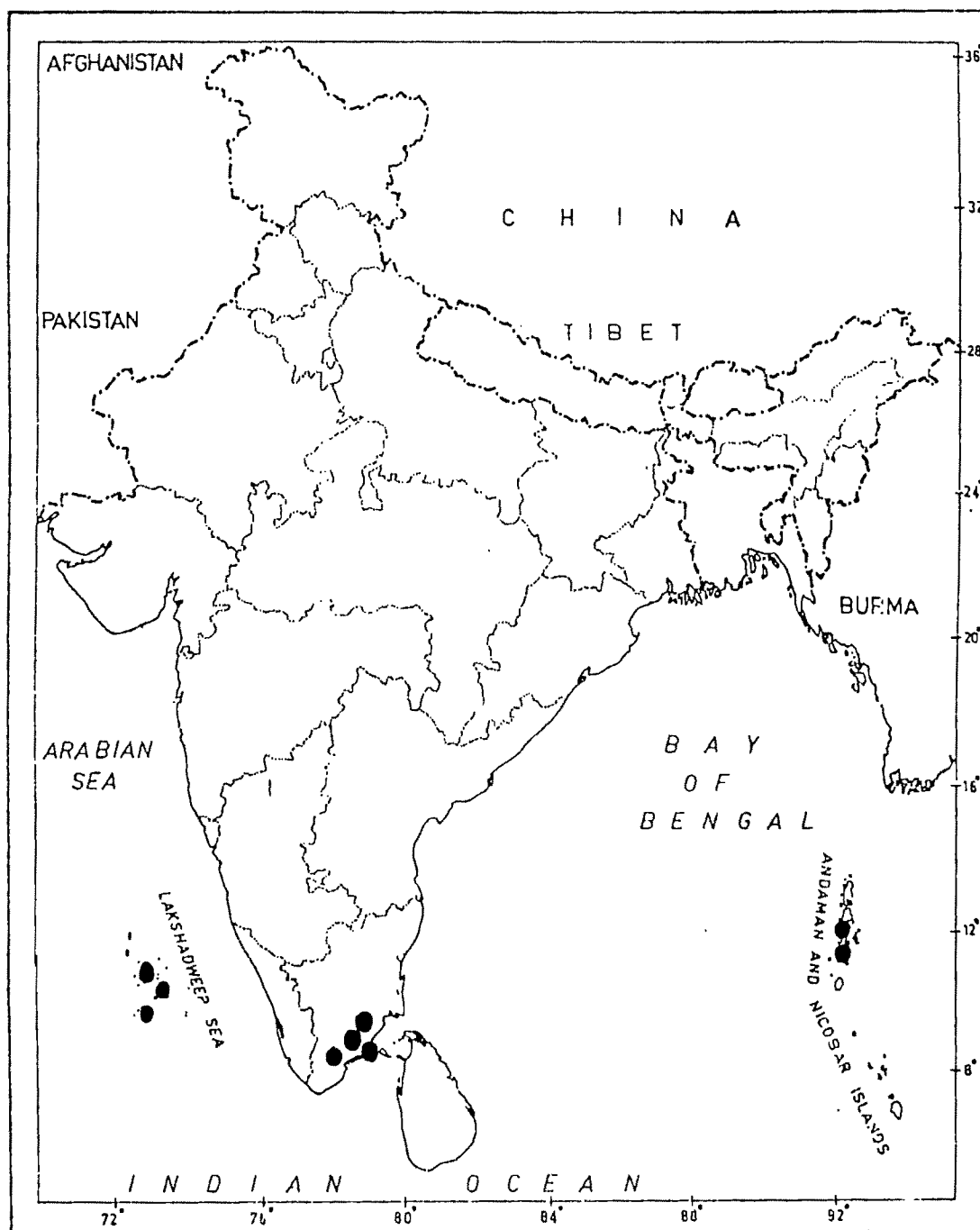
Pemphis angustifolia Roxb., Fl. Indica 2: 465. 1832.

Maclellandia griffithiana Wight, Icon Pl. Ind. Or. 6: t. 1996. 1853.

Shrubs or small trees, 5-10 m tall; branches grey pubescent at young, glabrous at maturity. Leaves 2-4 cm long, subsessile, ovate or oblong-lanceolate, cuneate at base, rounded at apex, grey pubescent on both surfaces, entire, coriaceous, 1-nerved. Flowers upto 1 cm long, white; pedicels 0.5-1 cm long, bibracteolate at the base. Calyx tube c. 5 x 4 mm, campanulate, puberulous, lobes 6, c. 1 mm long, erect, triangular; appendages 6, spreading. Petals 6, c. 6 x 4 mm, white, obovate or oblanceolate, shortly clawed, obtuse at apex, cuneate or attenuate at base. Stamens 12, alternate ones shorter, all included within the calyx tube. Ovary 3-4 mm long, turbinate, sessile, many ovuled; style filiform, 1-5 mm long, distylous; stigma capitate. Capsules 0.5-0.75 cm diameter, globose, coriaceous, circumscissile dehiscent. Seeds numerous, 3.0-3.5 x 1.5-2.5 mm, deltoid to cuneate compressed, the chalazal end broadest.

Fls. & Frts. : October - May.

Distribution: INDIA: Tamil Nadu, Kerala (Bourdillon, 1908), Lakshadweep Islands, Andaman & Nicobar Islands; SRI LANKA; BURMA; JAVA; SIAM; AUSTRALIA; EAST AFRICA; PACIFIC ISLANDS.



Map 8. Distribution of *Pemphis acidula* in India.

Chromosome number:  $2n = 32$  (Lewis, 1975).

Palynology: Pollen prolate-spheroidal, amb square; tetra colporate with 8 faint pseudocolpi, colpi meridionally elongated, equatorially arranged, equidistant, straight, 25-35  $\mu\text{m}$  long, extending within 8-10  $\mu\text{m}$  of pole, P/E 1.2, margin entire, gradually tapering to slightly rounded to acute apex, costae colpi 1.5-2  $\mu\text{m}$  wide, ectexine bridge frequently evident over pore, pseudocolpi represented by slightly increased granulation in equatorial mesocolpial region, two on each side of slight mesocolpial ridge, shorter than colpi (c. 14-18  $\mu\text{m}$ ), otherwise like colpi, pore circular, diameter 10-14  $\mu\text{m}$ , situated at midpoint of colpus, margin entire, narrow annulus; wall 2  $\mu\text{m}$  thick to 3-3.5  $\mu\text{m}$  in mesocolpial region reflecting slight mesocolpial ridge, psilate to faintly scabrate; tectate; 40-55 (-67) p x 30-40 (-54) E  $\mu\text{m}$  (Graham et al., 1987).

Specimens examined:

TAMIL NADU: s. loc. Wight 981 (CAL); Rameswaram Island, July 1888, Thurston 3 (MH); Tuticorin, September 1900, without collector Acc. No. 21894 (MH); Tuticorin, 2.10.1916, without collector 13711(MH); Ramanathapuram, Krusadi Island, 10.5.1943, Iyer s.n. (MH); Krusadai,

19.5.1944, Daniel & Parthasarathi s.n. (DD); Krusadi Island 25.12.1960, Rao 616 (CAL); Rameswaram Island, 17.5.1962, Rao 14932 (CAL).

ANDAMAN & NICOBAR ISLANDS: S. Andamans, Goplakalang Hill jungle, 16.9.1895, King's collector s.n. (CAL); S. Andamans, Escape Bay, Kurz s.n. (CAL); Rutland Island, 12.1.1916, Parkinson 866 (DD); Havelock Island, 23.2.1916, Parkinson 1033 (CAL, DD); Cinque Island, 12.3.1964, Thothathri 9276 (CAL, MH); Cinque Island, 20.4.1964, Ellis & Ramamurthy 18899 (MH); Corbyn's cove, Edges of Mangrooves, 31.10.1973, Balakrishnan 549 (CAL); Corbyn's Cove, sea level, 24.8.1977, Jain & Balakrishnan 6090 (CAL).

LAKSHADWEEP ISLANDS: Kalpatti, 23.2.1959, Srinivasan 1693 (CAL); Kalpatti Island, 23.2.1959, Wadhwa 48975 (CAL); Minocoy Island, 27.11.1961, Wadhwa 68404 (CAL).

## 7. ROTALA

*Rotala* L., Mant. Pl. Alt. Gen. 143. 1771; DC., Prodr. 3: 75. 1828; Wight & Arn., Prod. Fl. Penin. Ind. Or. 1: 303. 1834; Blume, Mus. Bot. Lugd. - Bat. 2(9): 136. 1856; Baillon, Hist. Pl. 426. 1877; Koehne in Engl., Bot.

Jahrb. 1: 142. 1881 & in Engl., Pflanzenr. 17(6, 216):  
 22. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc.  
 25: 701. 1918; Leeuwen, Blumea 19(1): 53. 1971; Iqbal  
 Dar, in Nasir & Ali, Fl. West Pakistan 78: 12. 1975;  
 Cook, Boissiera 29: 12. 1979; Joseph & Sivar., Proc.  
 Indian Acad. Sci. (Plant Sci.) 99(3): 179. 1989.

Ammannia L., Sp. Pl. 119. 1753, Proparte.

Peplis L., Sp. Pl. 332. 1753, proparte.

Suffrenia Bellardi, Mem. Acad. Sci. Turin. 7: 445. t. 1. f.  
 1. 1803.

Sellowia Roth ex Roemer & Schult., Syst. Veg. 5(31): 407.  
 1819.

Winterlia Spreng., Syst. 1: 519. 1824.

Boykinia Rafin., Neogenyton 2. 1825.

Ameletia DC., Mem. Soc. Phys. Geneve 2(2): 82. 1826.

Nimmonia Wight, Madras J. Lit. Sci. 5: 312. 1837.

Nexilis Rafin., New. Fl. 4: 9. 1838.

Hypobrichia Curtis ex Torrey & Gray, Fl. N. Amer. 1: 479.  
 1840.

Rhyacophila Hochst., Flora 24: 659. 1841.

Quartinia Endl., Gen. Suppl. 2: 94. 1842.

Hydrolythrum Hook. f. in Hook., IC. Pl. Ser 2. t. 1007. 1843

Tritheca (Wight & Arn.) Miq., Fl. Ind. Bat. 1(1): 614. 1855.

Ditheca (Wight & Arn.) Miq., Fl. Ind. Bat. 1(1): 615. 1855.

Ammannia subgenus Rotala (L.) Clarke in Hook. f., Fl. Brit.

India 2: 566. 1879.

Type: Rotala verticillaris L., Mant. Pl. Alt. Sp. 2: 175. 1771.

Annual or ~~perennial~~ perennial, glabrous herbs of aquatic or marshy habitats. Stems floating, creeping, ascending or erect, simple or branched, quadrangular or terete. Leaves sessile or shortly petioled, decussate, verticillate or rarely alternate, linear to oblanceolate or ovate, cordate to attenuate at base, obtuse, acute or bifid at apex, membranaceous. Flowers regular, sessile or shortly pedicillate, monomorphic or dimorphic, axillary, solitary or in terminal spikes, 3-5 (-6) merous; bracteoles 2 or rarely absent, at the base of calyx tube, opposite. Calyx tube campanulate, globose, cylindrical or urceolate, 1-3 mm long, membranaceous; calyx lobes 3-5-(-6), acute to acuminate or



rarely obtuse, often subulate; appendages shorter than or exceeding the lobes or absent; nectaries often present at the base of calyx tube. Petals 0-5(-6), small or large and showy, entire or dissected, caducous, rarely persistent, white or pink. Stamens 1-5(-6), episealous, rarely staminodes present in between; anthers included or exserted. Ovary sessile or shortly stipitate, incompletely 2-4 locular, upper portion of ovary esepate; ovule few or many, placentation axile becoming free central at maturity; style simple, larger than ovary and exserted or shorter than ovary and included or absent; stigma capitate or rarely bilobed. Fruits a membranaceous, septicidally dehiscent capsule, 2-4 valved, with transverse striations on the outer wall. Seeds minute, many or few, ovoid, ellipsoid or hemispheric with convex outer and flat inner surfaces.

#### Historic and Taxonomic consideration

In 1771 Linnaeus first established the genus Rotala, the name derived from the Latin word, rota, meaning wheel, in allusion to the whorled leaves of the type species.

The genus had been confused for a long period and the confusion was partly due to Linnaeus. Prior to the description of Rotala, Linnaeus (1737) established the genus

Ammannia and later (1753) assigned to it three species viz., A. latifolia, A. ramosior and A. baccifera. But in that work he failed to recognise A. ramosior as a member of the genus Rotala. This confusion existed until the differences between the genera were finally clarified by Koehne (1880). Before Koehne's work, De Cadolle (1828), Wight & Arnott (1834), Wight (1840) and Blume (1856) recognised Ammannia and Rotala as distinct genera but at the same time described a few new genera such as Ameletia DC, Nimmonia Wight, etc., as synonymous to Rotala. Baillon (1877) and Hiern (1871) also recognised Rotala as good genus.

On the contrary, Benthām & Hooker f. (1867) rejected the genus Rotala and grouped the species of Ammannia in two sections, viz., section I, with flowers sessile and solitary and capsule valvular dehiscent, including the species referred to Rotala and section II having species with flowers pedicellate, solitary or cymose and capsules irregularly or transversely dehiscent referred to true Ammannia. Clarke (1879) attributed subgeneric status to the two sections of Ammannia proposed by Benthām & Hooker f.

Koehne (1880, 1903) merged 14 generic names proposed after 1771 as congeneric and synonymous with Rotala, the generic names are: Suffrenia Bellardi, Boykinia Raf.,

Sellowia Roth ex Roem. & Schult., Winterlia Spreng, Aneletia DC., Nexilis Raf, Nimmonia Wight, Rhyacophila Hochst, Quartinia Endl., Hydrolythrum Hooker f., Ditheca Miq., Tritheca Miq., and Hydrolythrum Benth. He finally clarified the differences between the genera Ammannia and Rotala and successfully put an end to the long persisted confusion. He distinguished the genera mainly on the nature of dehiscence of capsule. In agreement with Koehne (1903), Blatter & Hallberg (1918), Gamble (1919) Hutchinson & Dalziel (1927), Keay (1954), Graham (1964), Webb (1968), Leeuwen (1974), Cook et al. (1974), Panigrahi (1976) and Cook (1979) recognised Rotala as a Distinct genus. They summarised the following combination of characters to set apart Rotala from its closely allied genus Ammannia: presence of solitary axillary flowers, septicidally dehiscent capsule and transverse striations on the outer wall of capsule. While in Ammannia, the flowers are in axillary cymes or clusters, the capsule dehisces irregularly and the outer wall of the capsule is smooth.

#### Ecology and Distribution

Rotala characteristically grows in wet, relatively open habitats from sea level to 2500 m. It colonises shallow marshes, temporal pools, roadside ditches, paddy fields and

other intermittently wet areas. Some species such as R. verticillaris, R. wallichii, etc., grow as emergent aquatics showing a character-complex of erect, unbranched stems with simple, elongate leaves borne in symmetrical whorls. Cook (1978) called this character-complex as 'Hippuris syndrome'. Rest of the species are semi-aquatics or terrestrials growing in marshy lands have opposite decussate leaves.

Based on the arrangement of leaves Koehne (1880, 1903) divided the genus into two sections: the whorled-leaved species constituting the section 'Hippuridium' and the section 'Enantiorotala' having decussate leaves. Cook (1978, 1979) considered that the whorled leaves are as a result of direct response to the aquatic environment and so opined that it does not constitute a single phyletic group when floral characteristics and distributions are considered. He clarified this by stating that R. mexicana and R. myriophylloides mimic Hippuris when they are growing as emergent aquatics, but when they grow terrestrially, they often have decussate leaves. He also opined that the genus, being very uniform, does not yield to a satisfactory subgeneric classification that can subdivide the genus into natural groups.

*Rotala* is a genus of about 45 species, best represented in Asia and Africa, a few occurring at Australia, America and USSR. In India the genus is represented by 20 species. From a consideration of the distribution table (Table 1) it is possible to distinguish 'generalist' species, with wide ecological and geographical amplitude, from restricted species which are confined to particular habitats in specific areas. Among Indian *Rotala*, the following wide species may be identified, *R. mexicana*, *R. densiflora*, *R. rotundifolia* and *R. indica*. These species generally show high levels of infraspecific diversity compared to other more restricted species. Interestingly, these variations are not in a definite pattern for assigning infraspecific categories within this group. The above mentioned characteristic of the group is reflected in its taxonomy by means of a number of synonyms and an array of subspecific, varietal and formic level treatments. Cook (1979) commented that, many species show considerable variation but it is folly to attempt any infraspecific classification on a very wide spread group of aquatic and amphibious plants without an experimental approach.

India also has many restricted species, showing highly localised patterns of distribution. The relationship between habitat specialisation and endemism is particularly

Table 1. Geographical Distribution of the species of the Genus Rotala L. in India

Species of <u>Rotala</u>	JAMMU & KASHMIR	HIMACHAL PRADESH	PUNJAB	HARYANA	UTTAR PRADESH	BIHAR	WEST BENGAL	SIKKIM	ARUNACHAL PRADESH	ASSAM	NAGALAND	MIZORAM	MANIPUR	MEGHALAYA	TRIPURA	ORISSA	MADHYA PRADESH	RAJASTAN	GUJARAT	MAHARASHTRA	ANDHRA PRADESH	TAMIL NADU	KARNATAKA	KERALA	GOA	ANDAMAN & NICOBAR
R. cookii	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. cordata	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. densiflora	+	+	-	-	+	+	+	-	-	-	-	-	+	+	-	+	+	-	-	-	+	+	+	+	+	-
R. fimbriata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. floribunda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. illecebroides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. indica	+	+	-	+	+	+	+	+	-	+	-	-	+	-	+	+	+	-	-	+	+	+	+	+	+	+
R. macrandra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. malampuzhensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. mexicana	+	-	+	-	+	+	+	+	-	+	-	-	-	+	-	+	+	-	+	-	+	+	+	+	+	+
R. occultiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. ritchiei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. rosea	-	-	+	-	+	+	+	-	-	+	-	-	-	+	+	+	+	-	-	+	+	+	+	+	+	+
R. rotundifolia	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	-	-	+	+	+	+	+	+	+
R. rubra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. serpyllifolia	-	-	-	-	+	+	+	+	-	+	+	-	+	+	+	+	+	-	-	+	+	+	+	+	+	+
R. simpliciuscula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. verticillaris	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	+	-	-	+	+	+	+	+	+	+
R. wallichii	-	-	-	-	-	-	+	+	-	+	+	-	+	+	+	+	+	-	-	+	+	+	+	+	+	+

striking in the case of Indian Rotala. Of the 20 species growing in India, seven occupy somewhat similar climatic zone and are endemic to India, especially peninsular India. Specialisation is most marked in those endemics which are morphologically highly distinct, very restricted in distribution and not apparently closely related to other species. These are probably relic species (Palaeo-endemics) and are usually found in small, isolated and distinctive habitats. R. floribunda is the most extreme example of this, being found at one locality, only on Mahabaleshwar Hills of Maharashtra and it is unique in the genus having alternate ericoid aerial and flaccid submerged leaves and a bilobed stigma.

It is likely that other endemic species which are less isolated taxonomically and geographically have evolved recently from more widely distributed species which are in the process of expanding their range. The other pattern of distribution which emerges considering the phytogeography of Indian Rotala is that all the seven endemic species are restricted to peninsular India, a region which is not exposed to extreme winter and summer but receiving a fair amount of rainfall by means of both the Northeast and Southwest monsoons.

Anatomy

Anatomical features of stem and leaves have been described for 10 species by Panigrahi (1988) and the diagnostic features are: Stem - Epidermal cells squarish, rectangular, angular or oval, 6-36  $\mu$ m high. Hypodermis parenchymatous or collenchymatous, 1-3 layered. Cortex aerenchymatous, 1-2 (-3) layered, air-chambers large, regular, squarish, polygonal or radially elongated, lining cells parenchymatous. Endodermis distinct with radial walls thickened as casparian strips. Vascular tissue forms a continuous cylinder except for the leaf gaps. Xylem tissue varies between 48  $\mu$ m to 310  $\mu$ m in radial thickness and is encircled by the external and internal phloem rings. Pith hollow, parenchymatous with or without air spaces and fibres. Leaf - Isobilateral or centric; lamina 57-270  $\mu$ m thick. Epidermal cells squarish, oval, angular or tabular. Mucilage cells round, oval or elongated, solitary or in groups of 2-4 cells. Stomata, raised, level or depressed with short blunt ledges. Mesophyll of large and elongated palisade cells in 1-3 layers on the adaxial and small-celled, 1-layered on the abaxial surface; spongy tissue 1-2 layers in between the palisade layers, variously shaped; irregular air spaces present or absent. Midrib indistinct or conspicuous, trapezoid or rectangular in shape or semi-circular or oval on the abaxial side; collenchymatous or parenchymatous both adaxially and abaxially.



Chromosome numbers:  $2n = 32$  (Graham 1964)

Palynology: Pollen prolate to prolate-spheroidal, amb circular to more lobate reflecting slight mesocolpial ridges and protruding pores; tri- to tetracolporate with 6 faint pseudocolpi, colpi meridionally elongated, equatorially arranged, equidistant, straight, ranging from weakly developed and short (c. 7-10  $\mu\text{m}$ ) to more prominent and longer (10-15  $\mu\text{m}$ ), extending within 4-6  $\mu\text{m}$  of pole (PI 0.23), P/E 1.2, faint to more prominent, narrow costae colpi (c. 1-1.5  $\mu\text{m}$  wide), tapering to acute to rounded apex, margin entire, pseudocolpi shorter (8-12  $\mu\text{m}$ ), otherwise like colpi, pore prominent, circular to more elongated equatorially, diameter 3-4  $\mu\text{m}$ , situated at midpoint of colpus, margin entire, annulus c. 1  $\mu\text{m}$  wide; wall 1-1.5  $\mu\text{m}$  thick, scabrate to finely verrucate, regulate bordering colpus; tectate; 18-24 P x 15-20 E  $\mu\text{m}$  (Graham et al., 1990).

#### Key to the species

- 1a. Leaves in whorls of 3 or more
- 2a. Petals absent.
- 3a. Leaves with sheathing base; bracteoles enclosing the flower; capsule ellipsoid and exceeding the calyx tube .... R. occultiflora 11
- 3b. Leaves without sheathing base; bracteoles not enclosing the flower; capsule globose and exceeding the calyx tube .....R. mexicana 10

2b. Petals present:

4a. Flowers trimerous, calyx tube  
cylindrical ..... R. verticillaris 19

4b. Flowers tetramerous, calyx tube  
campanulate:

5a. Bracts lanceolate or oblong;  
petals c. 2.5 mm long, larger  
than calyx; anthers level with  
the top of calyx tubes ..... R. wallichii 20

5b. Bracts linear; petals c. 0.8 mm  
long, shorter than calyx;  
anthers reaching up to the  
mouth of calyx tube ..... R. cookii 1

1b. Leaves alternate or opposite  
decussate:

6a. Leaves alternate; stigma  
bilobed ..... R. floribunda 5

- 6b. Leaves opposite decussate;  
stigma unilobed:
- 7a. Flowers in terminal pedunculate  
spikes:
- 8a. Calyx tube sub-cylindrical,  
constricted at the throat  
capsule 2-valved ..... R. serpyllifolia 16
- 8b. Calyx tube campanulate, not  
constricted' capsule 4-valved:
- 9a. Bracteoles as long as calyx  
tube; anthers and stigmas  
included, stigma discoid ..... R. rotundifolia 14
- 9b. Bracteoles half the length of  
calyx tube; anthers and stigmas  
exserted; stigma minutely  
capitate ..... R. macrandra 8
- 7b. Flowers axillary, solitary on  
main stem or lateral branches:

10a. Leaves petiolate; bracteoles  
absent ... R. simpliciuscula 17

10b. Leaves sessile; bracteoles  
present:

11a. Flowers trimerous; presence of  
staminode like appendages  
alternating with stamens. ... R. malampuzhensis 9

11b. Flowers tetramerous or pentamerous;  
staminode like appendages  
absent:

12a. Flowers tetramerous:

13a. Leaves margin cartilaginous;  
capsule 2-valved:

14a. Flowers pedicellate; petals  
large, two times longer than  
calyx lobes; anthers exserted .... R. subrotunda 18

- 14b. Flowers sessile; petals minute,  
half as long as calyx lobes;  
anthers included with in the  
calyx tube. .... R. indica 7
- 13b. Leaves margin non cartilagi-  
nous; capsule 3 or 4-valved:
- 15a. Margin of the calyx lobes  
toothed; capsule 3-valved:
- 16a. Leaves cordate at base; capsule  
included within the calyx tube;  
style 1-1.5 mm long. .... R. cordata 2
- 16b. Leaves cuneate at base; capsule  
exceeding the calyx; style very  
short, c. 0.1 mm .... R. rubra 15
- 15b. Margin of the calyx lobes  
entire; capsule 4-valved.
- 17a. Flowers pedicellate; calyx tube  
sub-cylindrical, lobes obtuse;  
capsule ellipsoid. .... R. ritchiei 12

17b. Flowers sessile; calyx tube  
 campanulate, lobes acuminate;  
 capsule globose ..... R. illecebroides 6

12b. Flowers pentamerous:

18a. Petals fimbriate, pinnately  
 divided into linear segments;  
 anthers exserted; capsule  
 ellipsoid ..... R. fimbriata 4

18b. Petals entire or wavy, not  
 pinnately divided; anthers  
 included within the calyx tube;  
 capsule globose:

19a. Bracteoles shorter than or  
 equal to flowers; capsule  
 exceeding the calyx; style very  
 short, c.0.25 mm. .... R. rosea 13

19b. Bracteoles longer than flowers;  
 capsule not exceeding the  
 calyx; style 0.5-1 mm long .... R. densiflora 3

1. *Rotala cookii* Joseph & Sivar., Pl. Syst. Evol. 159. 143, 1988.

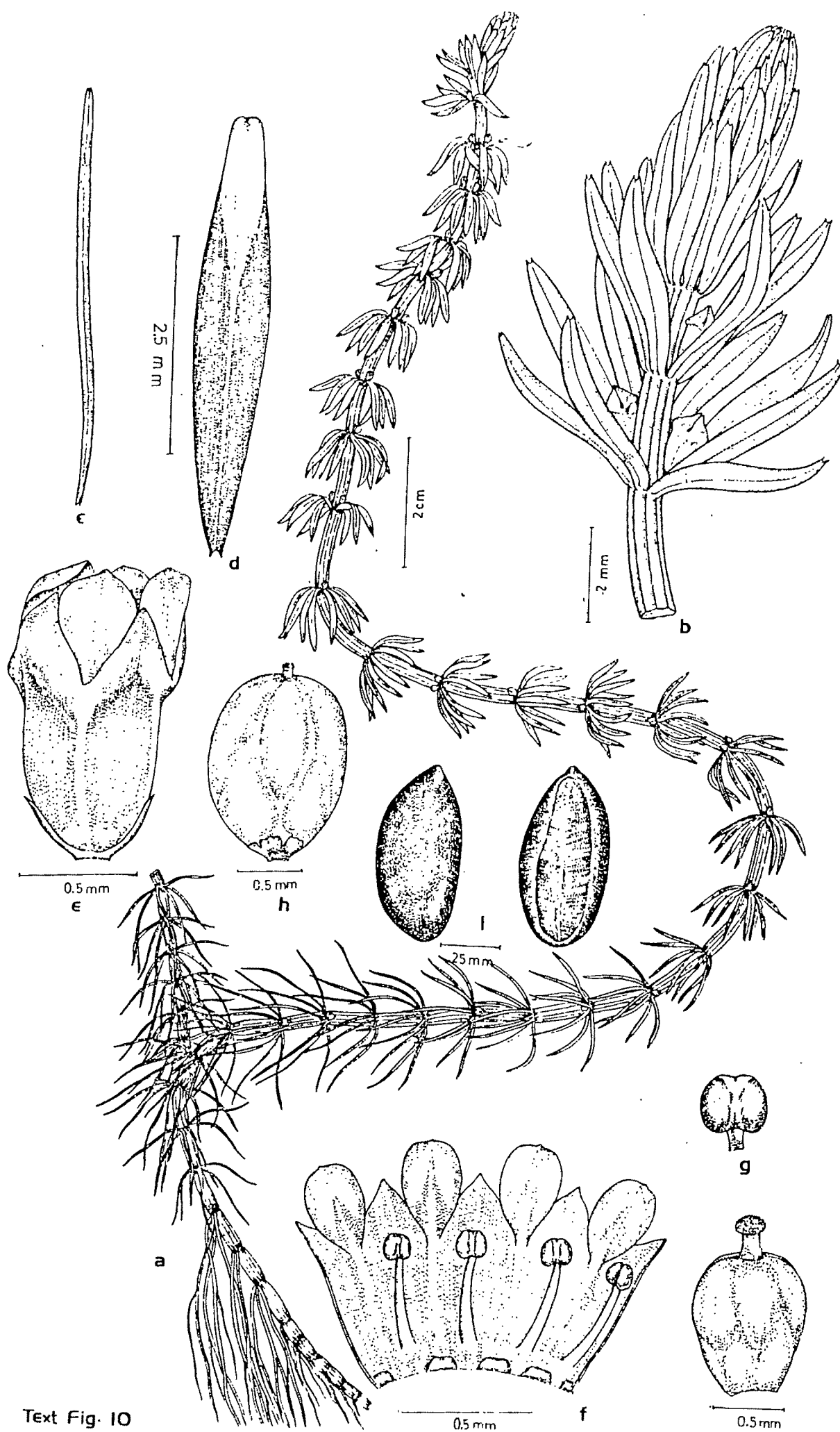
*R. vasudevanii* Joseph et Sivar., Proc. Indian Acad. Sci. (Plant Sci.) Vol. 99 (3): 195. 1989. synonym nova.

Submerged annual, stem up to 40 cm long, creeping and rooting below. Leaves in whorls of 7-10, dimorphic; submerged leaves capillary, often reflexed, to 15 mm long, microscopically bimucronate at apex; aerial leaves broader, spreading, linear, to 6 x 0.8 mm, bimucronate at apex, narrowed towards base. Bracts leaf-like. Bracteoles linear, c. 0.5 mm long, shorter than calyx tube, persistent in fruit. Flowers 2-4 in each node, those on submerged shoot cleistogamous and those on emergent branches normal, sessile. Calyx tube campanulate, to 1 mm long, splitting and disintegrating as the fruit ripens, lobes 4, deltate, to 0.5 mm long. Petals 4, obovate-obtuse, white, alternating with calyx lobes, to 0.8 mm long. Stamens 4, anthers borne level with the base of petals. Nectar scales 4, small, greenish yellow or pink, minute, broader than long, apex obtuse or truncate. Ovary globose. Style simple, short, persistent. Stigma capitate, minutely papillose. Capsules globose, to 1.2 mm across, opening by valves. Seeds 4-5, semi-ellipsoidal, to 1 mm long (Text Fig.10).

Text Fig. 10. Rotala cookii Joseph et Sivar.

- a. Habit
- b. Upper portion of the shoot enlarged
- c. Submerged leaf
- d. Aerial leaf
- e. Flower
- f. Flower dissection
- g. Anther
- h. Capsule
- i. Seed dorsal and ventral view.





Text Fig. 10

Type: INDIA: Kerala, Malappuram, Parappanangadi,  
December 1983, Joseph 38967 (Holo:CAL\*; Iso: CALI\*, MH\*, Z).

Fls. & Frts. : October - December

Ecology : R. cookii grows abundantly in flooded paddy fields during the rainy season, in association with Hydrilla veticillata, Wiesneria triandra, Limnopoa meeboldii, and Nymphoides indica.

Distribution: INDIA: Kerala(Map 9).

Notes: Vasudevan Nair (1965) reported Rotala wallichii (as Hydrolythrum wallichii) based on his own collection from Alwaye, Kerala. Joseph & Sivarajan (1988) described a new species, Rotala cookii, from Kerala and stated that allied to R. wallichii, but can easily be recognized from it by almost equal number of leaves in the submerged and emergent whorls, petals shorter than the calyx, unlobed nectar scales and anthers on level with the point of insertion of petals. In 1989, Jeseoph & Sivarajan again published a new species, R. vasudevanii based on vasudevan Nair's above mentioned collection from Always, Kerala. They opined that it allied to both R. wallichii and R. cookii, from R. wallichii it

differs in its monomorphic leaves arranged in whorls of 9-12 in both submerged and emergent parts, bracteoles more than half as long as the calyx tube, included stamens with apiculate connectives, and imperfectly bilobed nectar scales. From R. cookii it differs in its monomorphic leaves, larger bracteoles and in the absence of cleistogamous flowers.

In critical observation of the type specimen of R. vasudevanii the author found that the leaves shows dimorphism, the emergent leaves (upper whorls) are small, linear, 8-10 mm long and the submerged leaves (lower whorls) are long capillary, 15 mm or more long. As regarding the length of bracteoles, from the original description of R. cookii it is revealed that the length of bracteole is half or more than half as long as calyx tube (ie length of bracteoles c. 5 mm and length of calyx tube 0.7-1 mm long), the same is mentioned in the case of R. vasudevanii also, bracteoles more than half as long as the calyx tube. The type specimen of R. vasudevanii (Vasudevan Nair 39977) is in very bad condition and it is very difficult to make out the presence or absence of cleistogamous flowers. It seems the author's of R. vasudevanii purely depended the plate and description of R. wallichii of vasudevan Nair for describing their new

species. In taking account of all these facts the author prefer<sup>s</sup> to reduce R. vasudevanii as a synonym of R. cookii Joseph et Sivarajan.

Specimens examined:

KERALA: Malappuram, Parappanangadi, December 1983, Joseph 38967 (CAL, CALI, MH); Chettipadi, Punnakusypalam, 25.10.1988, Joseph 39071 (CALI).

2. ***Rotala cordata*** Koehne in Engl., Bot. Jahrb. 1: 172. 1880 & in Pflanzennr. 17(4, 216): 41. 1903; Blatt. & Hallb., J. Bombay Nat. Hist Soc. 25: 710. 1918; Cook, Boissiera 29: 93 1979.

R. diversifolia Koehne in Engl., Bot Jahrb. 11: 77. 1907.

Amphibious or terrestrial annual herbs. Stems c. 30 cm long, branched, reddish-brown, 4-winged; wings whitish, discontinuous, passing in to the leaf margin at each internode. Leaves decussate, 7-17 x 2-6 mm, ovate-lanceolate or oblong, cordate at base, obtuse at apex. Flowers monomorphic, subsessile, 4-merous, solitary in axils of bracts. Bracts leaf-like, c. 5 mm long, recurved, red. Bracteoles 2, minute, c. 0.3 mm or less long, reaching 1/4 the length of calyx tube. Calyx tube broadly campanulate,

c. 1 mm long, lobes 4, c. 0.5 mm long, triangular, acuminate at apex, margin toothed. Petals 4, 0.75-1 mm long, longer than calyx lobes, obovate, persistent. Stamens 4, inserted half way down the tube, included. Ovary c. 1 mm long, globose, 3-loculed; style 0.5-1 mm long; stigma capitate, exserted. Capsule 1-1.5 mm across, globose, 3-valved, included with in the calyx tube. Seeds c. 0.5 mm long, ovoid.

Type: Mons. Ind. Or. : Bengal reg. trop., Hooker f. & Thomson s.n., mixed with R. pentandra (Holo. - G; iso. CAL\*).

Fls. & Frts. : August - March

Ecology: Growing mostly in mountainous regions where it grows near streams and waterfalls.

Distribution: INDIA: Bihar, West Bengal, Orissa; NEPAL; BURMA; THAILAND; VIETNAM; INDONESIA; NEW GUINEA (Map 9).

Specimens examined:

ORISSA: Ganjam, Bondogorha, 450 m, march 1884, Gamble 14071 (CAL).

WEST BENGAL: Bengal, Hooker f. & Thomson s.n. (CAL);  
 Darjeeling, Siliguri, December 1874, Gamble 527 (CAL);  
 Darjeeling Terai Siliguri, December 1874, Gamble 3024 &  
 3024 B (DD).

3. *Rotala densiflora* (Roth ex Roemer & Schult.) Koehne in  
 Engl., Bot. Jahrb. 1: 164. 1880 & in Pflanzenr 17(4,  
 216): 35 1903, Gamble, Fl. Pres. Madras 1: 508. 1919;  
 Hara, Fl. East. Himal. 218. 1966; Van Leeuwen, Blumea  
 19: 55 1971; Cook, Boissiera 29: 82. 1979; Joseph &  
 Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3):  
 181. 1989.

Ammannia densiflora Roth ex Roemer & Schult., Syst. Veg. 3:  
 304. 1818; Roth, Ncv. Spec. Pl. Ind. Or. 99. 1821; DC.  
 Prodr. 3: 79. 1828; Wight & Arn., Prodr. 1: 305. 1834;  
 Blume, Mus. Bot. Lugd. Bat. 2: 134. 1856.

Ditheca densiflora (Roth ex Roemer & Schult) Miq., Fl. Ind.  
 Bat. 1(1): 615. 1855.

Sellowia uliginosa Roth ex Roemer & Schult., Syst. Veg. 5:  
 407. 1819; Roth, Nov. Sp. Ind. Or. 156. 1821; DC,  
 Prodr. 3: 380. 1828.

Winterlia uliginosa (Roth ex Roemer & Schult.,) Spreng.,  
Syst. 1: 788. 1825.

Rotala roxburghiana Wight, Ic, Pl. Ind. Or. 1: t. 260 B,  
1840.

Ammannia pentandra sensu Clarke in Hook. f., Fl. Brit. India  
2: 568. 1979 p.p; Blume, Mus. Bot. Lugd. Bat. 2: 134.  
1856.

Rotala pentandra (Roxb.) Blatt. & Hallb., J. Bombay Nat.  
Hist. 25: 707. 1918 p.p.

Amphibious or terrestrial annual herbs. Stems erect,  
up to 59 cm long, tetragonous, winged, simple or branched.  
Leaves decussate, rarely alternate or in whorls of 4, 3-25 x  
1-5 mm, linear-lanceolate, ovate or oblong, cordate at base,  
acute or obtuse at apex, clasping. Bracts dimorphic, those  
on main stem and lower branches leaf-like and those on upper  
branches considerably smaller, ovate or elliptic, scarcely  
exceeding flower. Flowers monomorphic, solitary, sessile in  
axils of bracts. Bracteoles 2, c. 1.5 mm long, linear-  
lanceolate, acuminate at apex, exceeding calyx tube, midrib  
prominent, pink. Calyx tube campanulate, 1 mm long; lobes 5  
rarely 4, c. 0.5 mm long, triangular, acute to acuminate;  
appendages 5, alternating with calyx lobes, as long as or

longer than calyx lobes, linear. Petals 5 or rarely 4, 0.5-1.5 mm long, obovate, obtuse or retuse at apex, pink, persistent. Stamens 5 or rarely 4, attached below the middle of calyx tube; anthers borne level with calyx lobes. Ovary c. 0.75 mm, globose, trilocular; style c. 0.5 mm long; stigma capitate, exserted. Capsule globose, 3-valved, as long as or included with in calyx tube. Seeds semi-ovoid, c. 0.5 mm long (Fig. 8 & 9).

Type: India Orientalis B Heyne (Iso.-L)

Fls. & Frts. : July - February.

Distribution: INDIA: Jammu & Kashmir, Himachal Pradesh, Bihar, West Bengal, Tripura, Manipur, Orissa, Madhya pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Goa; USSR; PAKISTAN; SRI LANKA; AUSTRALIA; NEW BORNEO; ITALY.(Map 9).

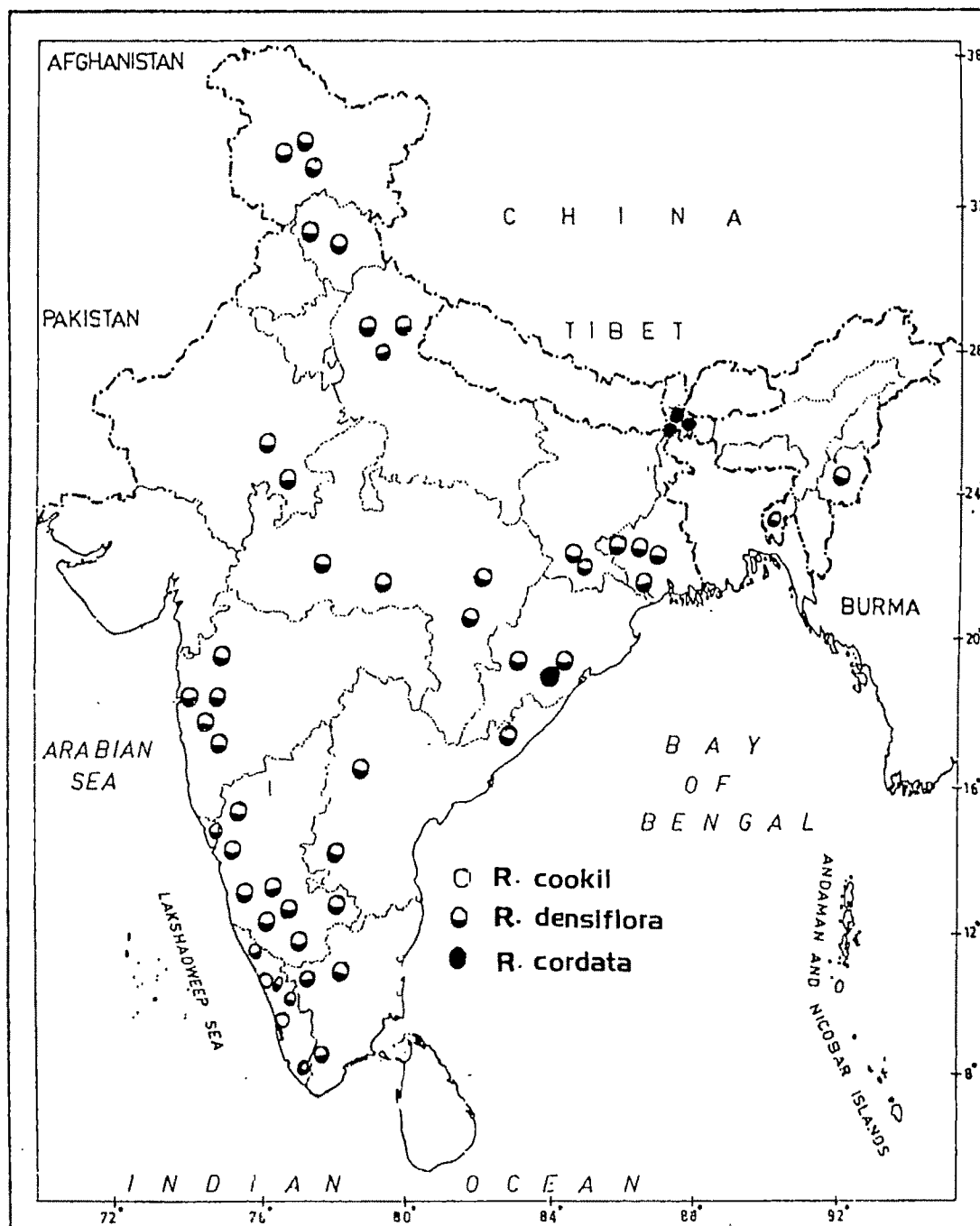
Notes: R. densiflora grows in marshy places, paddy fields and the sides of small streams. It is a highly variable species. Variation is chiefly found in the size and shape of the leaves and petals and the relative length of calyx appendages with respect to calyx lobes.



Fig. 8. Habit of Rotala densiflora (Roth ex Roem. & Schult.)  
Koehne - Field view.

Fig. 9. A flower of Rotala densiflora (Roth ex Roem. &  
Schult.) Koehne - A closer view.





Map 9. Distribution of *Rotala cookii*, *R. densiflora* and *R. cordata* in India.

Koehne (1880) recognised three subspecies and a number of varieties and formas. These subspecies are not geographically distinct and all of his infra specific groups are based on the above mentioned variable characters. In this species the variability does not appear or follow any discernable pattern. Even in a single plant all the variations can be found. So the infra specific taxa proposed by Koehne (1880) are not considered here.

Specimens examined:

ANDHRA PRADESH: Hyderabad, 1834, Campbell s.n. (CAL); Visakaptnam, Araka valley, 825 m, 15.9.1961, Balakrishnan 581 (CAL); Anatapur, Kalasamudram, 8.2.1983, Yesoda 1177 (CAL).

BIHAR: W. Ranchi, Lohardaga, 600 m, November 1880, Gamble 8765 (CAL, DD); Chota Nagpur, Lohardaga, Lodhma, 600 m, November 1883, Clarke 34200 (CAL); Chota Nagpur, Jashpurnager, 25.11.1890, Wood 126 (MH); Chota Nagpur, November 1891, Prain s.n. (DD); Ranchi, 7.9.1896, Khokim s.n. (CAL); South Bihar, 15.6.1965, Kanodia 1295 (CAL).

GOA: Margao, October 1908, Meebold 10280 (BSI); Panjun - Margao, near Santacruz village, 8.11.1962; Rao 84418 (BSI); Budsari, Goundungarha, 10.11.1962, Rao 84566 (BSI); Valpoy, 17.11.1962, Rao 84900 (BSI); Porvorim, 5.9.1963, Kanodia 89798 (BSI); Codal, 5.10.1964, Raghavan 103292 (BSI); Tudal, 11.10.1964, Raghavan 103512 (BSI); Pernem - Agarvado, 7.9.1965, Cherian 93096 (BSI); Corazal, 30.9.1970, Singh 124832 (BSI).

HIMACHAL PRADESH: Kangra, between Dharmasala and Dadh, 1216 m 22.9.1896, Gammie 18678 (DD); Kulu Valley, Manali, 14.9.1949, Nath 4374 (DD).

JUMMU & KASHMIR: Kashmir, Harwan R.F., 28.7.1956, Rao 837 (CAL, BSD); Banihal Valley, 12.9.1958, Rao 7510 (BSD); Eein Nallah, 3.9.1960, Malhotra 12222 (BSD); Achabal, August 1969, Darmadhikari & Koul AW/27 (CAL).

KARNATAKA: Mysore, 1866, Wight 974 (CAL); N. Kanara, Yellapore, December 1883, Talbot 870 (CAL); N. Kanara, Siddapore, 15.11.1884, Talbot 1054 (CAL); Hossore, 17.11.1884, Talbot 1066 (CAL, DD); N. Kanara, Kadra, 7.11.1887, Talbot 1586 (DD); Mysore, Aglati, 1065 m, February 1908, meebold 8235 (CAL); Belgaum, Khawpur,

Hatargunji, 3.1.1959, Ahuja 47658 (BSI); Shimoga, Agumbe - Begur route, 8.2.1961, Raghavan 69490 (BSI, CAL); Coorg, Abbey falls, 26.1.1976, Banerjee 11351 (CAL); Kolar, Udappanahalli, 7.7.1978, Ramesh & Ravindra 1478 (CAL); Belgaum, Near Gunji, 28.10.1978, Saldanha & Prakash 3710 (CAL); Hassan, Bourdalboore State forest, 900 m, 26.12.1978, Saldanha, Prakash & Manohar 5456 (CAL); Chikmagalur, Datatreyaapeetha, Bababudan Hills, 27.9.1979, Saldanha 9554 (CAL).

KERALA: Travancore, Puliya, 7.9.1913, RamaRao 1675 (CAL); Quilon (Travancore), Shenkottai to Aryankavu, 8.9.1913, Calder & Ramaswami 694 A (CAL); Palghat, Olavakkot, 75 m, 16.10.1963, Joseph 17709 (MH); Cannanore, Manantoddy, 700 m, 11.2.1970, Ramachandran 53870 (CAL, MH); Cannanore, Kannothe R.F., 140 m, 21.2.1979, Ramachandran 60083 (MH).

MADHYA PRADESH: Chanda, Kaulsa 18.12.1889, Duthie 9479 (DD); Raipur, September 1959, Sethi 4 (DD); Saugor, near Mohli tank, 6.11.1960, Balakrishnan 11512 (CAL, MH); Bastar, Way to Jayathgiri, 550 m, 12.2.1961, Balakrishnan & Henry 12088 (CAL); Bilaspur, Daramjaygarh, 30.4.1964, Arora 3805 (CAL); Bilaspur, Korba, 17.4.1965, Panigrahi & Arora 8688 (CAL).

MAHARASHTRA: Khandala, Dukes Nose, 1065 m, September 1907, Meebold 8909 (BSI, CAL); Bombay, Kanheri caves, 300 m, March 1918, Sedjwick 3715 (BLAT); Poona, Talao near Alandighat, 1.10.1962, Janardhanan 78298 (BSI); Poona, Saltar Village, Ambave - Mulshi taluk, 7.9.1964, Reddi 99080 (CAL); Nasik, Igatpuri, 5.2.1983, Narasimhan 165359 (BSI); Nasik, Ambewadi, 16.9.1986, Narasimhan 167534 (BSI); Satara, Mahabaleshwar, Dhobis falls, 6.1.1988, Mathew 13114.

MANIPUR: Imphal, 28.1.1960, Mukherjee 5236 (CAL); Imphal Valley, 30.1.1960, Panigrahi 13493 (CAL).

ORISSA: Ganjam, Bonta, 150 m, February 1884, Gamble 13788 (DD); Ganjam, 22.1.1900, Barber 1171 (MH); Kalahandi, Jamchua, 608 m, 22.1.1943, Mooney 2179 (DD).

TAMIL NADU: Tirunelveli, Mundanthurai, 210 m, 19.2.1913, Hooper & Ramaswami 39352 (CAL); Salem, Hoganakkal, 240 m, 10.2.1927, Jacob 17984 (MH); Tirunelveli Junction Railway Station, 30.9.1943, Daniel & Raju 20480 (MH); Tirunelveli, Papanasam, 70 m, 28.2.1960, Sebastine 9977 (CAL, MH).

TRIPURA: Ananganagar near Feri., 16.3.20, Debberman 1190 (CAL).

UTTAR PRADESH: Pithoragarh, Chabori, 15.10.1975, Arora 56873 (BSD); Tehri, Dhopardhar, 1500 m, 24.9.1979, Goel 67814 (BSD).

WEST BENGAL: Without precise locality, December 1866, Kura s.n. (CAL); Purulia, Ajodhya Hill, 700 m, 25.12.1958, Sengupta 2061 (CAL); Bankura, Kotiam Hill, 120-150 m, 26.12.1958, Sengupta 2092 (CAL); Burdwan, February 1959, Kachroo s.n. (CAL); Bankura, Jaypur, Kashipur, 28.2.1965, Sanyal 591 (CAL); Purulia, Matha, Muneybera forest, 14.2.1970, Malick 942 (CAL); Midnapore, Kanyaduba, 26.2.1975, Maji IIII (CAL).

4. *Rotala fimbriata* Wight, Ic. Pl. Ind. Or. 1: t. 217. 1840; Koehne in Engl., Bot. Jahrb. 1: 166. 1880 & in Pflanzenr. 17 (4, 216): 37. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 710. 1918; Gamble, Fl. Pres. Madras 508. 1919; Cook, Boissiera 29: 80. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99 (3): 182: 1989.

Ammannia pentandra Roxb. var. fimbriata (Wight) Clarke in Hook. f., Fl. Brit. India 2: 569. 1879.



Ammannia heyneana Wallich, Cat. No. 2104. 1828, nom. nud.

Aquatic or amphibious annual herbs. Stems 10-40 cm long, creeping and rooting below, erect above, simple or branched, tetragonous, often 4-winged. Leaves decussate, sessile, 10-28 x 2-4 mm, oblong or lanceolate, obtuse at apex, auriculate-cordate at base. Flowers monomorphic, sessile, solitary in axils of bracts; bracts 5-15 mm long, leaf-like; bracteoles 2, c. 1 mm long, ovate, acute. Calyx tube campanulate, 2-2.5 mm long, lobes 5, c. 0.5 mm long, deltoid; appendages absent. Petals 5, 2-2.5 mm long, deeply fimbriated into linear segments, pink. Stamens 5, filaments 3-4 mm long, inserted near the base of calyx tube; anthers exserted. Ovary 1-1.5 mm, shortly stipitate, ellipsoid; style c. 2 mm long; stigma capitate, borne level with anthers. Capsule c. 3 mm long, ellipsoid, 3-valved. Seeds c. 1.5 mm long ellipsoidal (Text Fig. 11).

Type: Wight, Ic, Pl. Ind. Or. 1: t. 217. 1840 (Lecto.)

Fls. & Frts. : August - December

Distribution: INDIA: Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Goa. Endemic in peninsular India. (Map 10).



Text Fig. 11

Text Fig. 11. Rotala fimbriata Wight

- a. Habit
- b. Flower at anthesis
- c. Flower dissection
- d. Capsule

Specimens examined:

ANDHRA PRADESH: Cuddapah, Horsleykunda, August 1889, Gamble 21171 (CAL); Horsleykunda, 31.8.1918, Fischer 4424 (CAL); Karimnagar, Kodagutta, 450 m, 30.9.1965, Subbarao 25687 (MH).

GOA: Sanvordem, October 1908, Meebold 10282 (CAL).

KARNATAKA: Bellary, Hurati, September 1887, S. Coll (MH); Badami, 8.9.1911, Bhide s.n. (BSI); Mysore, Nandi Droog, 17.9.1911, Anstead 116(MH); Mandya, Ranganthittu, 25.11.1978, Murthy & Prakash 4571 (CAL).

TAMIL NADU: Salem, Hosur, 11.12.1917, S. coll (MH); N. Arcot, near Jolarpet, Elageres, December 1939, Barnes s.n. (DD); Coimbatore, Poonachi-Anamalais, 1100 M, 24.10.1961, Joseph 13240 (MH).

5. *Rotala floribunda* (Wight) Koehne, Verh. Bot. Vereins Prov. Brandenburg 19(14): 49. 1877 & In Engl., Bot. Jahrb. 1: 156. 1880 & in Engl., Pflanzenr. 17(4, 216): 32. 1903; Blatt. & Hallb., J. Bombay Nat. Hist Soc. 25: 706 1918; Cook, Boissiera 29: 43. 1979. Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 183. 1989.

Nimmonia floribunda Wight, Madras J. Lit. Sci. 5: 312, t. 20.  
1837.

Ameletia floribunda (Wight) Wight in Hooker, Ic. Pl. Ser.  
2, 5 t. 826. 1840, Ill. Ind. Bot. 1: 206. 1840.

Ammannia floribunda (Wight) Clarke in Hook. f., Fl. Brit.  
India 2: 567. 1879; Cooke, Fl. Pres. Bombay 1: 506.  
1903.

Amphibious or terrestrial herbs. Stems creeping and rooting below, erect and branched above, erect portion c. 35 cm long, subterete, reddish. Leaves alternate, sessile, dimorphic; submerged leaves c. 80 x 4 mm, linear; aerial leaves c. 5 x 0.5 mm linear-lanceolate, cordate or auriculate. Bracteoles 2, c. 2 mm, lanceolate. Flowers dimorphic, heterostylous, pedicelled, in terminal racemes; racemes c. 1 cm long, dense, peduncled. Calyx tube campanulate, 2-2.5 mm long, pink; appendages absent. Petals 4, 1-1.5 mm long, obovate, rose. Stamens 4, inserted below the middle of calyx tube; filaments up to 4 mm long and anthers exerted in short styled flowers, filaments up to 1 mm long and anthers included in long styled flowers. Nectar scales 4, prominent. Ovary c. 1 mm long, ellipsoid; styles 0.5 to 3.5 mm long; stigmas bilobed, included or

exserted. Capsules c. 1 x 0.75 mm, ellipsoid, 2-valved. Seeds semi-ellipsoid, c. 0.4 mm long, brownish yellow.

Type: Wight's illustration in Madras J. Lit. Sci. 5: t. 20. 1837 is designating here as lectotype.

Fls. & Frts. : September - March

Distribution: INDIA: Maharashtra. Endemic to Mahabaleshwar Hills of Maharashtra (Map 10).

Notes: 1. Wight (1837) described Rotala floribunda based on Nimmons collection. Cook (1979) opined that this particular specimen may be present in CAL or MH. Cook(1979) also suggested that Wight's illustration in Madras J. Lit. Sci. 5: t. 20. 1837 is good and may be used as a standard pending examination of the holotype. Due to the unavailability of Nimmon's collection, which is the holotype of this species, Wight's illustration in Madras J. Lit. Sci. 5: t. 20. 1837 is now designated as the lectotype.

2. A gregarious well branched herb on wet rocks in Mahabaleshwar, where it is a local endemic and called as Mahabaleshwar heather. It grows in dense masses and present a beautiful appearance due to its pink - coloured flowers.

3. It is allied to R. serpyllifolia but can easily be distinguished by the presence of dimorphic, alternate, linear-lanceolate leaves; short racemes; larger petals and bilobed stigma.

Specimens examined:

MAHARASHTRA: Without precise locality, 1878, Dalzell s.n. (CAL); ibid, 1884, Cooke 33 (CAL); Satara, Mahabaleshwar, 3.1.1891, Cooke s.n. (BSI); ibid., 20.10.1908, Talbot 4519 (BSI); ibid., December 1910, Sedgwick & Bell 7757 (BLAT); Mahabaleshwar, Chinaman's fall, 11.11.1950, Santapau 11953, 11954 & 11955 (BLAT); ibid., 27.12.1950, Bole 105 (BLAT); Dhobis falls, 19.12.1954, Kapadia 952 (BLAT); Lingmala falls, 25.2.1956, Mahajan 15 (BSI, CAL); Dhobis falls, 25.2.1956, Mahajan 32 (BSI); Mahad Roadghat, 12.10.1960, Ansari 67667 (BSI); Ratnagiri, Sangameshwar, Gothane, 16.9.1984, mistry 1693 (BLAT).

6. Rotala illecebroides Koehne in Engl., Bot. Jahrb. 1: 161. 1880 & in Pflanz. 17(4, 216): 34. 1903; Gamble, Fl. Pres. Madras 1: 508. 1919; Rajagopal & Ramayya, Curr. Sci. 37: 386. 1968; Cook, Boissiera 29: 72. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99 (3): 184. 1989.

Ammannia pentrandra Roxb., Var. illecebroides Arn. ex Clarke  
in Hooker f., Fl. Brit. India 2: 569. 1879.

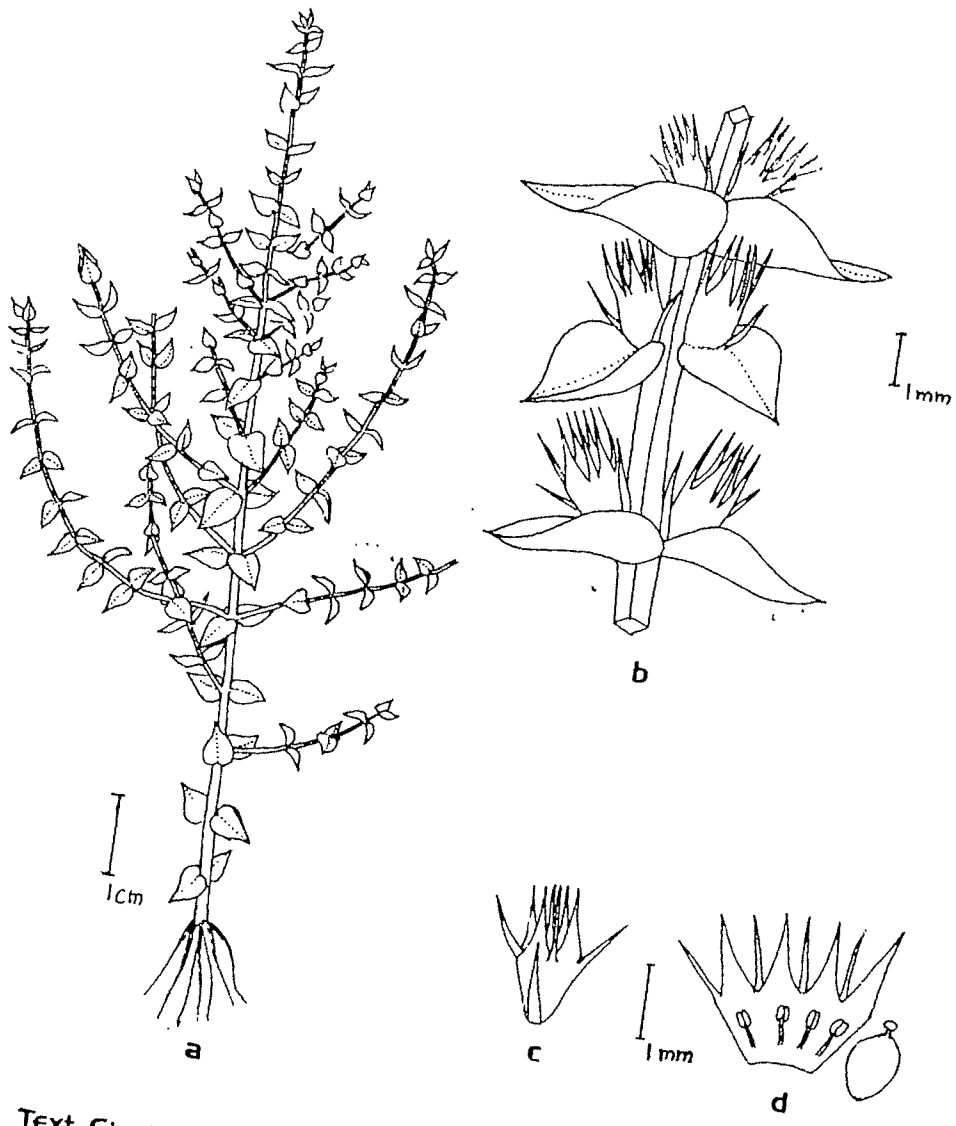
Rotala fysonii Blatt. & Hallb., J. Bombay Nat. Hist. Soc.  
25: 709. 1918; Fyson, Fl. S. Indian Hill Stat. 1: 683.  
1977 (Repd. ed.).

Aquatic or amphibious annual herbs. Stems slender, erect, 1.5-10 cm long, simple or branched, tetragonous. Leaves sessile, decussate, 1.5-4 x 1-3 mm, ovate-cordate, semi-amplexicaul, acute at apex. Flowers monomorphic, sessile, axillary, solitary; bracts leaf-like; bracteoles 2, linear, c. 1 mm long. Calyx tube campanulate, c. 1 mm long, lobes 4, c. 1 mm long, triangular acuminate; appendages 4, linear, as long as or slightly longer than calyx lobes, curving outwards. Petals absent or if present minute. Stamens 4, inserted little below the middle of calyx tube; anthers included. Ovary globose, 4-loculed; style inconspicuous; stigma capitate. Capsule c. 1 mm long, globose, 4-valved. Seeds ovoid. (Text Fig. 12).

Type: Peninsula Ind. Orientalis, Herb. Wight No. 2317  
(Holo. - K, Photo. CAL\*; iso. - K, G)

Fls. & Frts.: November - May.





Text Fig. 12

Text Fig. 12. Rotala illecebroides Koehne

- a. Habit
- b. Flowering node enlarged
- c. Flower
- d. Flower dissection

Ecology: It grows on wet surfaces in hilly and rocky areas and also in paddy fields. Associated species are Drosera burmanii, D. indica, Eriocaulon quinquangulare etc.

Distribution: INDIA: Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka (Map 10).

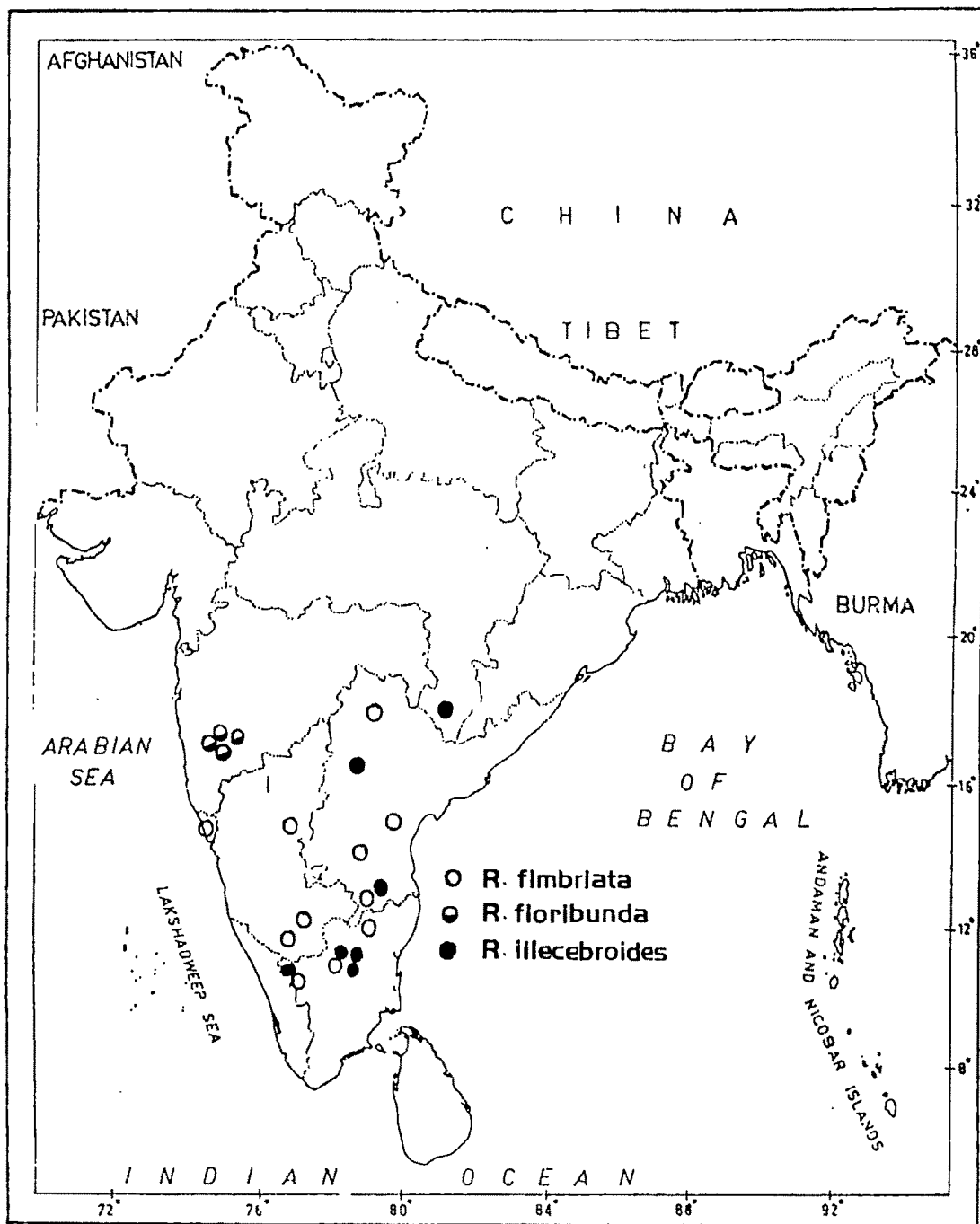
Notes: Earlier reported from the states of Andhra Pradesh, Tamil Nadu and Karnataka. Recently Almeida et al. (1989) recorded this taxon from Maharashtra under the binomial R. decussata DC., a rejected name and given R. illecebroides Koehne as synonym.

It is being reported here for the first time from Madhya Pradesh.

Specimens examined:

ANDHRA PRADESH: Chittoor, Horsleykonda, 1060 m, 1.5.1918, Fischer 4335 (CAL); Hyderabad, Theemala kunta, 400 m, 20.2.1968, RajaGopal 578 (BSI).

MADHYA PRADESH: Bastar, Kondagaon north, 767 m, 20.11.1958, Subramanyam 7230 (CAL, MH).



Map 10. Distribution of *Rotala fimbriata*, *R. floribunda* and *R. illecebroides* in India.

TAMIL NADU: Coimbatore, Anaimalais, Attakatti, 1100 m, 27.12.1911, Fischer 3218 (CAL); Anaimalais, Mount Stuart, 608 m, 10.12.1916, Fischer 4029 (CAL); Salem, Hosur, 29.12.1916, Fischer 4029 (CAL); Salem, Hosur, 10.12.1916, without collector 13962 (MH); Shevaroy, Green Hills, January 1941, Barnes s.n. (DD); Salem, Yercaud, Balmadies estate, 1666 m, 20.12.1958, Subramanyam 7561 (CAL, MH).

7. *Rotala indica* (Willd.) Koehne in Engl., Bot. Jahrb. 1: 172. 1880 & in Pflanzenr. 17 (4, 216): 40. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 711. 1918; Gamble, Fl. Pres. Madras 1: 508. 1919; Hara, Fl. East. Himal. 218. 1966; Van Leeuwen, Blumea 19: 54. 1971; Iqbal Dar in Nasir & Ali, Fl. west Pakistan 78: 12. 1975; Panigrahi, Indian Forester 102: 706. 1976; Hara in Hara & Williams, Enum. Flow. Pl. Nepal 2: 172. 1979; Cook, Boissiera 29: 114. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 184. 1989.

Peplis indica Willd., Sp. Pl. 2: 244. 1799.

Ammannia nana Roxb., Fl. Ind. 1: 448. 1820.

Ammannia repens Rottler & Martius, Acad. Munch. Philos. 6. 190. 1820

Ammannia peploides Spreng., Syst. 1: 444. 1824; Clarke in Hook. f., Fl. Brit. India 2: 566. 1879; Cooke, Fl. Pres. Bombay 1: 506. 1903; Trimen, Fl. Ceylon 2: 223. 1894; Duthie, Fl. Upp. Gang. Plain 1: 349. 1903; Prain, Bengal Plants 1: 500. 1903; Kanj. & Das, Fl. Assam 2: 316. 1938.

Ameletia indica (Willd.) DC., Mem. Soc. Phys. Nat. Hist. Geneve 3(2): 82. t. 3A. 1826 & Prod. 3: 76. 1828; Wight & Arn., Prod. Fl. Penin. Ind. Or. 303. 1834.

Ameletia polystachya Wall. ex Wight & Arn., Prod. Fl. Penin. Ind. Or. 304. 1834.

Ameletia uliginosa Miq., Fl. Ind. 1: 617. 1855.

Ameletia elongata Blume, Mus. Bot. Lugd. - Bat. 2: 135. 1856.

Aquatic or marshy annual herbs. Stems c. 40 cm long, erect or decumbent, much branched, rarely simple, tetragonous. Leaves 5-20 x 2-10 mm, sessile, decussate, obovate to spatulate or oblong, cuneate or attenuate at base, acute or obtuse at apex, mucronate, margin cartilaginous. Flowers monomorphic, sessile, solitary in axils of bracts. Bracts dimorphic, leaf-like on those of

main stem, elliptic-oblong or lanceolate on those of lateral branches. Bracteoles 2, c. 2.5 mm long, linear-lanceolate. Calyx tube 1.5-3 mm long, campanulate or tubular campanulate, 4-nerved, pink or red; lobes 4, 0.5-1 mm long, triangular, acute or acuminate, margin cartilaginous. Petals 4, c. 0.5 mm long, elliptic, persistent. Stamens 4, inserted at the middle of calyx tube; anthers included or level with the mouth of calyx tube. Ovary 1-1.5 mm long; ellipsoidal; style 0.5-1 mm long; stigma capitate, borne level with anthers. Capsule c. 2 mm long, ellipsoidal, 2-valved. Seeds 0.3-0.4 mm long, subspherical (Fig.10).

Type: India, 1795, Klein 546 (Holo.- B, Microfische CAL\*)

Fls. & Frts. : August - February

Distribution: INDIA: Jammu & Kashmir, Haryana (Cook, 1979), Uttar Pradesh, Bihar, West Bengal, Sikkim, Assam, Manipur, Tripura, Orissa, Madhya Pradesh, Rajasthan (Cook, 1979), Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Dadra & Nagar Haveli, Andaman & Nicobar Islands; SRI LANKA; NEPAL; BHUTAN; BANGLADESH; BURMA; THAILAND; MALAYSIA; LAOS; CAMBODIA; VIETNAM; INDONESIA; PHILIPPINES; CHINA; TAIWAN; JAPAN; KOREA; ITALY; PORTUGAL; USA; IRAN; AZERBAIJAN; TAJIKISTAN; AFGHANISTAN; PAKISTAN. (Map 11).

Fig. 10. Rotala indica (Willd.) Koehne - Field view of a population.

Fig. 11. Rotala malampuzhensis R.V. Nair ex C.D.K. Cook - Field view of a population.





Notes: Rotala indica shows a high degree of variability in its habit and shape of the flower. Because of these continuous variations, infraspecific treatments based on morphological characters are not advisable. Koehne (1880) and Blatter & Hallberg (1918) have recognised a number of infraspecific groups in this taxon, based on these highly variable morphological characters.

Specimens examined:

ANDHRA PRADESH: Warangal, Banks of Pakhal lake, 290 m, 29.11.1960, Sebastine 11678 (CAL); *ibid.*, 25.2.1963, Henry 15913 (CAL, MH).

ASSAM: Without precise locality, 1880, Masters s.n. (DD).

BIHAR: Chota Nagpur, Lohardugha, 5.12.1874, Clarke 25128 (CAL); *ibid.*, 10.11.1883, Clarke 34092 (CAL); Parasnath, November 1891, Prain s.n. (CAL); Kunjabana, 17.12.1957, Panigrahi 11879 (CAL).

GUJARAT: Dangs, Waghai, 26.12.1957, Asrana 5299 (BLAT).

KARNATAKA: North Kanara, Belekerrri, 5.12.1884, Talbot 1116 (CAL); North Kanara, Sampagi, 15.11.1900, Barber 2403 (CAL, MH); Coorg, Kalhalla, 5.1.1959, Arora 46164 (BSI); S. Kanara, Faringipet, 28.12.1979, Saldanha 10608 (CAL).

KERALA: Idukki, Anaipadi, Tekkadi forests, 540 m, 6.12.1912, Fischer 3520 (CAL); Idukki, Dhoni, 13.12.1920, Fischer 4575 (CAL, DD); Quilon, 10.1.1914, RamaRao 2322 (CAL); Trichur, Parambikulam, 607 m, 14.2.1963, Sebastine 15656 (MH); Trichur, Chalakudi, 100 m, 8.12.1965, Sebastine 26665 (MH); Quilon, Kulathupuzha R.F., 125 m, 20.2.1979, Mohanan 61158 (CAL, MH); Cannanore, Kannothe R.F., 140 m, 21.2.1979, Ramachandran 60089 (CAL); Palghat, Anamooly slopes, 325 m, 13.10.1979, Nair 64611 (CAL, MH).

MADHYA PRADESH: Chanda, 21.11.1889, Duthie 9487 (CAL, DD); Bastar, Keskai, 667 m, 16.11.1958, Subramanyam 7110 (CAL, MH); Bilaspur, Deorgaon, 670 m, 23.10.1960, Maheshwari 4066 (CAL); Mandla, Kheria R.F., 675 m, 26.11.1961, Joseph 13421 (CAL, MH); Gorakhpur, Pharendra, 31.10.1963, Arora 1412 (CAL); Bilaspur, Kathgora, 15.12.1964, Arora 3998 (CAL); Bilaspur, Kota, 29.10.1970, Panigrahi 13060 (CAL).

MAHARASHTRA: Bombay, Andheri, December 1916, Blatter & Hallberg 3259 (BLAT); Nasik, Igatpuri, January 1917, Blatter 3273 (BLAT); Khandala, 28.12.1943, Santapau 3484 (BLAT); Bombay, Madh island, 16.12.1956, Jain 9702 (CAL); Poona, Pandonagar hill, Ambavane, 20.12.1963, Reddi 93191 (BSI); Ratnagiri, Mangaon, 14.2.1966, Ansari 107713 (BSI); Thana, Talegaon, Tokavada range, 14.11.1968, Billore 115413 (BSI, CAL).

MANIPUR: Shibong, Naga hills, 912 m, December 1907, meebold 7475 (CAL).

ORISSA: Ganjam, Bondogorha, 450 m, March 1884, Gamble 14072 (CAL); Nendhra, 19.2.1961, Panigrahi 23945 (CAL); Kuru, Majlinpara, 8.1.1962, Verma 1593 (CAL); Kondamali Parbat, 11.12.1962, SubbaRao 30183 (CAL).

SIKKIM: Without Precise locality, 5.2.1867, Anderson s.n. (CAL, DD); Bajracote, 22.2.1911, Ribu & Rhomoo 4954 (CAL); Rishi, 510 m, 10.12.1980, Chakraborty 1108 (CAL).

TAMIL NADU: Nilgiri & Kurg, Thomson s.n. (CAL, MH); Thanjavur, Aduthorai, 14.2.1931, Narayanaswami 5248 (MH); Tirunelveli, Singampatti, Manimuthur, 66 m,

2.3.1958, Sebastine 5476 (CAL, MH); Nilgiri, Benne forest, 1125 m, 20.1.1961, Shetty 11961 (CAL, MH); Thiruchirappalli, Srirangam Island, Canvery banks, 10.2.1978, Mathew 11777 (CAL).

TRIPURA: West of Agartala, Shanmura, 27.12.1914, Debberman 394 (CAL); Damchara, 19.1.1962, Deb 26888 (CAL).

UTTAR PRADESH: Dehra Dun, Raspananadhi, 4.11.1961, Malhotra 18533 (BSD); Dehra Dun, Mathranwala, 13.11.1961, Bhattacharya 18440 (BSD); Mirzapur, T. Falls, 7.12.1961, Bhattacharya 18493 (BSD); Bahraich, 18.2.1963, Malhotra 26691 (BSD); Mirzapur, churk - sulhat, 22.10.1964, Panigrahi 2645 (CAL); Abdullagung, 7.11.1964, Panigrahi & misra 6385 (CAL).

WEST BENGAL: Burdwan, February 1959, Kachroo s.n. (CAL); Hooghly, Arambagh, 22.11.1961, Hazra 105 (CAL); Howrah, Kona, 11.12.1963, Bennet 475 (CAL); Bankura, Bishnupur, 18.12.1964, Sanyal 471 (CAL); 24-Paragnas, Mayapur, 19.12.1964, Ghosh 2669 (CAL); Nadia, Kalyani, 27.12.1971, Das 11418 (CAL); Midnapur, Kanyaduba, 21.11.1975, Maji 2062 (CAL).

ANDAMAN & NICOBAR ISLANDS: Port mount Hilljungle, 18.13.1893, King's Collector s.n. (CAL); Cadellganj Hilljungle, 13.4.1895, Kings Collector s.n. (CAL); Car Nicobar, Johnson's Village Hill jungle, 20.6.1895, Kings Collector s.n. (CAL); N. Andaman, Austin II, 15 m, 3.2.1959, Thothathri 9173 (CAL); S. Andamans, Oral katcha, Bamboonala village, Baratang, 20 m, 1.2.1978, Basu 6886 (CAL).

DADRA & NAGAR HAVELI: Nagar Haveli, Umperkoi 6.11.1970, Ansari 121915 (BSI); Nagar Haveli, Dhapsa, 16.11.1970, Ansari 127185 (BSI).

8. *Rotala macrandra*: Koehne in Engl., Bot. Jahrb. 1: 176. 1880 & in Pflanzenr 17 (4, 216); 41. 1903; Gamble, Fl. Pres. Madras 509. 1919; Cook, Boissiera 29: 54. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 185. 1989.

Ameletia rotundifolia Wight, Ic. Pl. Ind. Or. 1: t. 258. 1840.

Ammannia rotundifolia sensu Clarke in Hook.f., Fl. Brit. India 2: 566. 1879 pro part, non Buch. - Ham. ex Roxb. 1820.

Rotala rotundifolia sensu Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 718. 1918 pro part, non Koehne 1880.

Amphibious annual or perennial herbs. Stems up to 40 cm, branched below, simple above, terete below, 4-angled above, creeping and rooting below. Leaves decussate or occasionally in whorls of three in submerged part, sessile, dimorphic; submerged leaves, c. 5 cm long, linear-lanceolate; aerial leaves c. 2 x 2 cm, ovate to orbicular, cordate at base, obtuse or rounded at apex, nerves distinct, reddish tinged. Flowers in terminal, simple or branched pedunculate spikes, monomorphic, sessile, solitary in axils of bracts. Bracts 2-3 mm long, broadly ovate. Bracteoles 2, c. 0.5 mm long, linear. Calyx tube campanulate, c. 1 mm long, membranous, 4-nerved, pink; lobes 4, c. 1 mm long, triangular, acute. Petals 4, c. 2 mm long, obovate, obtuse at apex, rose. Stamens 4, inserted at the base of calyx tube; filaments 3-4 mm long; anthers exserted. Ovary globose, c. 1 mm long; style c. 3 mm long; stigma minutely capitate, level with anthers. Capsule, c. 1.5 mm across, globose, 4-valved. Seeds semi-ellipsoidal, c. 0.5 mm long. (Text Fig.13).

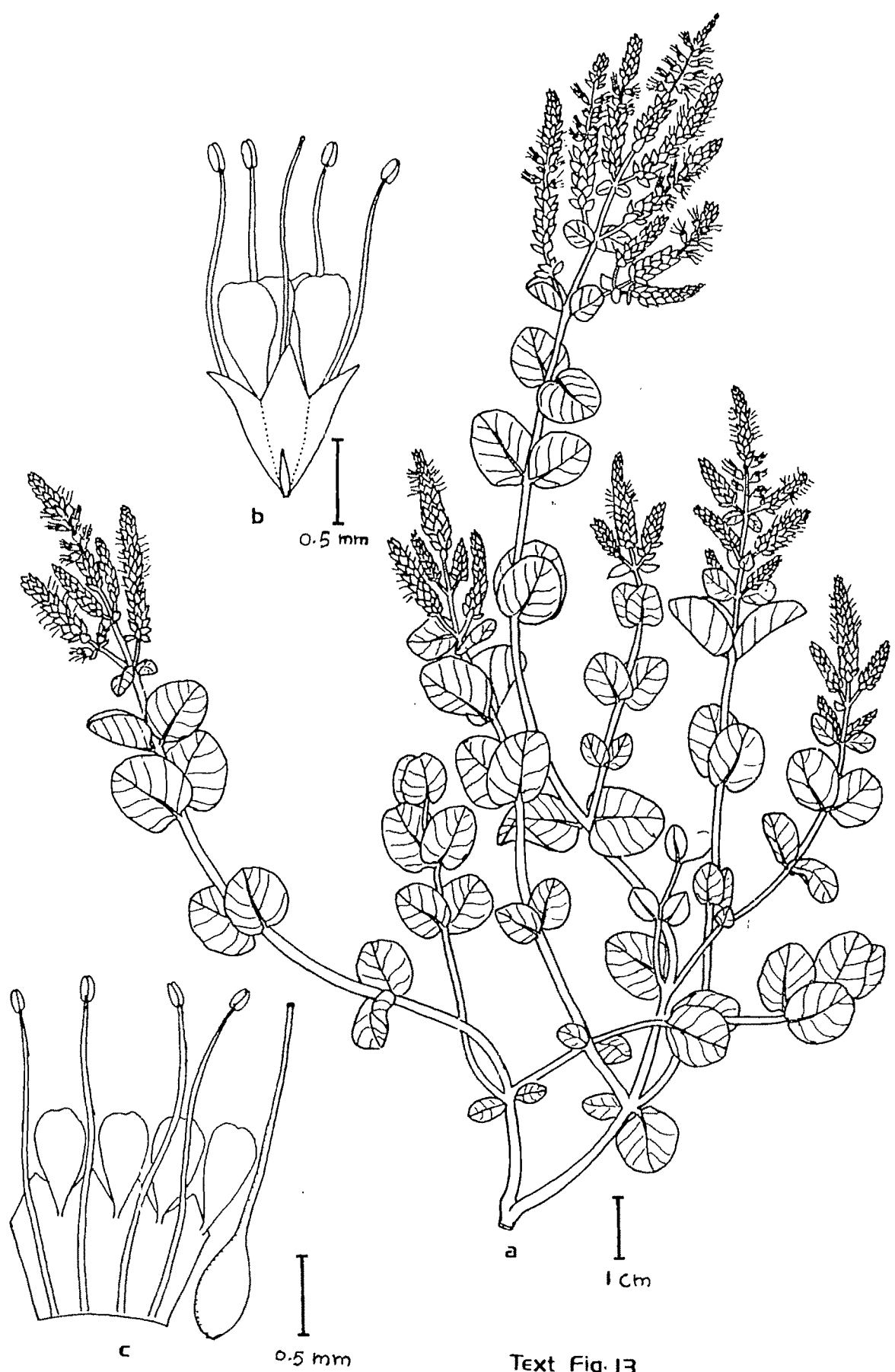
Type: Mons. Ind. Or. locis non indicatis, Wallich 2095H (Lecto. - K-W, photo: CAL\*; Isolecto: CAL\*, K, LE).

Fls. & Frts. : August-February.

Text Fig. 13. Rotala macrandra Koehne

- a. Habit
- b. Flower
- c. Flower dissection





Text Fig. 13

Ecology: A common weed in streams, ponds and flooded paddy fields. It usually found in the coastal regions of South-West India. The associated species are Blyxa aubertii, Vallisneria spiralis and Ludwigia parviflora.

Distribution: INDIA: Maharashtra, Karnataka, Tamil Nadu, Kerala, Goa (Map 11).

Notes: 1. Some of the earlier authors have treated R. macrandra Koehne and R. rotundifolia (Buch. - Ham. ex Roxb) Koehne as conspecific. Clarke (1879) while describing Ammannia rotundifolia (basionym of R. rotundifolia) observed the exserted stamens and styles but did not give much emphasis on this character. He mistook this as distyly as in the case of Lythrum salicaria L.

Koehne (1880) separated a group of plants having exserted stamens and styles from Rotala rotundifolia and described it as new. Blatter & Hallberg (1918) considered the length of stamens and styles as an unreliable character for its separation from R. rotundifolia. He treated it as conspecific to R. rotundifolia. Gamble (1919) and Cook (1979) considered R. macrandra as a distinct species.

After examining a number of living as well as herbarium specimens the author is of the opinion that the characters of R. macrandra <sup>pl</sup> is strong enough to treat it as a distinct species.

It resembles R. rotundifolia (Buch. - Ham. ex Roxb) Koehne but differs in having bracteoles half as long as calyx tube; compact inflorescence; well exerted stamens and styles and minutely capitate stigma.

2. R. macrandra Koehne is being recorded here for the first time from Maharashtra and Goa.

Specimens examined:

GOA: Angidev, Hillock, 24.9.1965, Cherian 106691 (CAL).

KARNATAKA: N. Kanara, Yellapore, 30.10.1883, Tabot s.n.(CAL); Mysore, Ananthapura, 600-900 m, October 1908, Meebold 10284 (CAL); N. Kanara, Avmod, 550 m, December 1917, Sedjwick 3814 (BLAT); N. Kanara, Siddhapur, October 1919, Hallberg & Mccann 35083 (BLAT); Belgaum, Londa, 10.12.1910, Raizada s.n. (BSI); N. Kanara, Yellapore, 17.11.1950, Braganza 721 (DD); Mysore, Gajanoor, Thirthahalli, 25.6.1961, Raghavan 74344 (BSI); Chikmagalur, Begaru, 15.12.1978, Prakash & Ramesh 5427 (CAL).

KERALA: Cannanore, Tellichery, 4.11.1900, Without Collector (MH); Cannanore, Kannothe, 8.12.1913, without collector 9511 (MH); Palghat, Peringothukavu, 325 m, 23.11.1973, Vajravelu 44811 (MH); Cannanore, Nileshevar, 9.10.1979, Ansari 64827 (CAL, MH); Calicut, Kadalundi, 9.12.1986, Jayalekha 8024 (CALI); Malappuram, Parappanangadi, 31.1.1989, Mathew 13140 (CAL).

MAHARASHTRA: Bombay presidency, 8.11.1950, Fernandes 1710 (CAL); Wapoli, November 1921, Acland 467 (BLAT); Ratnagiri, Amboli, 8.11.1965, Kulkarni 107916 (BSI); Ratnagiri, near River-Phonda, 25.10.1969, Kulkarni 118975 (BSI); Ratnagiri, Kankanli, Koloshi, 6.10.1970, Kulkarni 121511 (BSI); Ratnagiri, Chankal, Ambolighat, 12.8.1971, Kulkarni 131603-A (BSI).

TAMIL NADU: Nilgiri, 1871, Wight s.n., mixed with R. rotundifolia (MH); without precise locality, Wight 977, mixed with R. rotundifolia (CAL).

9. *Rotala malampuzhensis* R.V. Nair ex C.D.K. Cook, Boissiera 29: 98. 1979; Panigrahi & Nicols., Taxon 32: 120-122. 1983; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 186. 1989.

R. malampuzhensis R.V. Nair, J. Bombay Nat. Hist. Soc.  
72(1): 57. 1975, nom. inval. published without  
nomenclatural type.

Amphibious or terrestrial, annual herbs growing as dense masses. Stems branched, creeping and rooting below with numerous erect branches; erect portion 3-30 cm long, simple or rarely branched, quadrangular. Leaves decussate, sessile, 2-15 x 1-4 mm, linear-lanceolate, truncate or bifid at apex, cuneate at base. Flowers monomorphic, sessile, solitary, trimerous. Bracteoles 2, c. 1 mm long, about as long as or shorter than calyx tube. Calyx tube campanulate, c. 1 mm long, bright red; lobes 3, c. 0.5 mm long, triangular acute, bright red; appendages 3, very short. Petals 3, c. 0.5 mm long, linear-oblong, red. Stamens 3, inserted little above the base of calyx tube; anthers included. Nectar scales 3, alternating with stamens, linear, emarginate or slightly bifid at apex. Ovary globose; style inconspicuous; stigma capitate. Capsule c. 1.5 mm across, globose, bright red, exceeding the calyx tube. 3-valved. Seeds 10-15 per capsule, obovate, c. 0.6mm long, bright red. (Fig. 11 & 12).

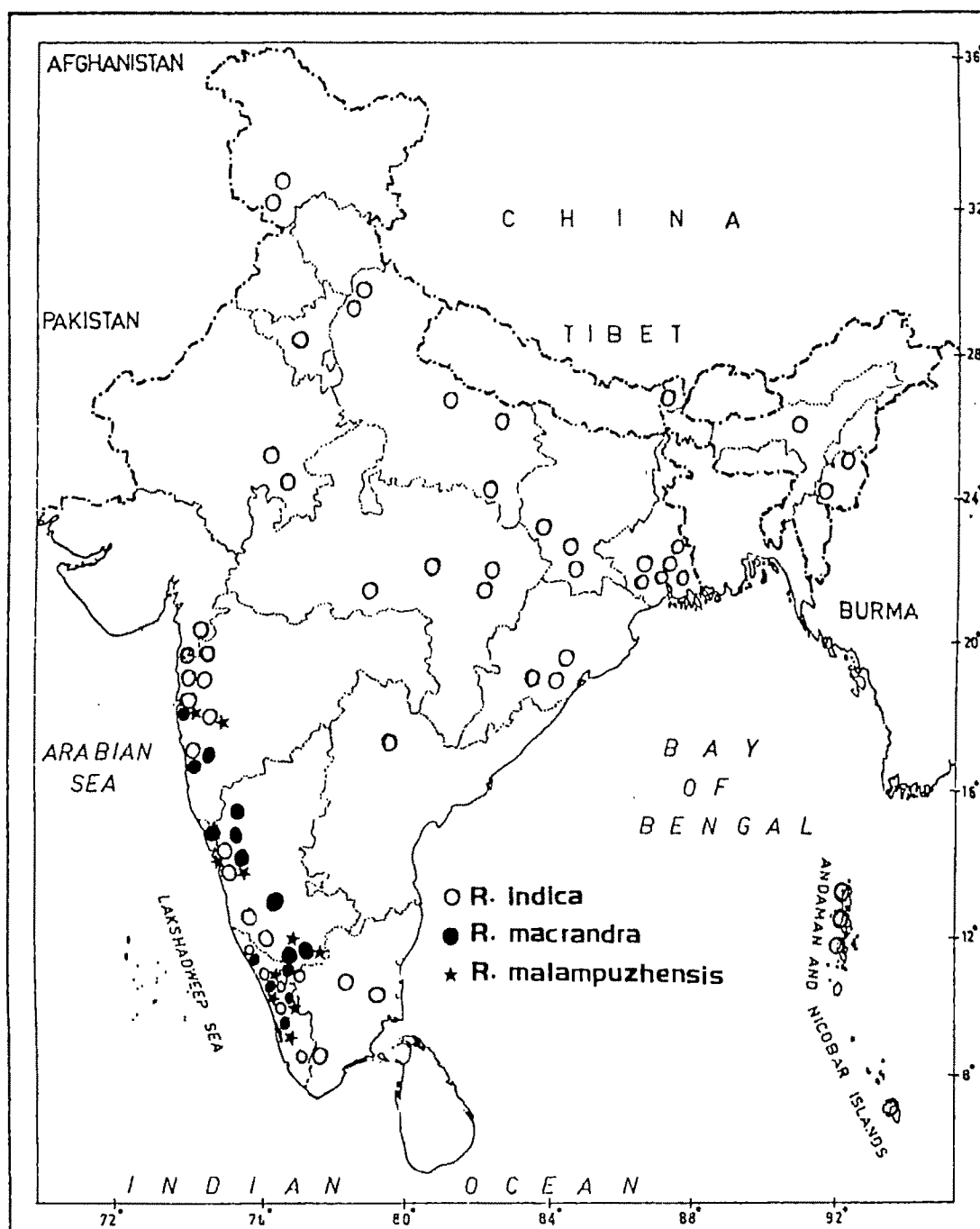
Type: India, Kerala, Palghat Dt., Malampuzha river, July 1971, Vasudeven Nair s.n., MH Acc. No. 89602. (Holo.-MH\*).

Fls. & Frts.: July - November

Ecology: A small, shortlived annual growing in roadside ditches, temporary pools and paddy fields along the Western costal plain.

Distribution: INDIA: Maharashtra, Karnataka, Kerala  
(Map 11).

Notes: While publishing R. malampuzhensis Vasudevan Nair (1975) cited four collections which he had collected from various parts of Kerala but he is failed to mentioned any particular collection as holotype. In the last paragraph of the paper he stated that "paratype specimens are desoposited at the herbarium of Botanical Survey of India, Southern circle, Coimbatore along with type. In 1976 he again published an addendum (in J. Bombay Nat Hist. Soc. 73(3): 248. 1976), saying that under R. malampuzhensis sp. nov. add the following "Holotype deposited in the Kew Herbarium (H. 868/68). Paratypes deposited in the Herbarium, Department of Botany, University of Calicut. In both the cases he does not tell us (that which) of his collection is the nomenclatural type. Consequently it is seen that in Kew Herbarium R. malampuzhensis collected by vasudevan Nair is not present. In Madras herbarium three of his collections are present. Cook C.D.K. (1979) while



Map 11. Distribution of *Rotala indica*, *R. macrandra* and *R. malampuzhensis* in India.

revising the genus Rotala selected India, Kerala, Palghat Dt., Malampuzha River July 1971 Vasudevan Nair s.n., MH acc. No. 86602 as holotype and validated his publication.

(2) R. malampuzhensis is being reported here for the first time from Maharashtra and Karnataka.

Specimens examined:

KARNATAKA: Mysore, Kanagalgudda, near Tirthahalli 19.8.1963, Raghavan 90003 (BSI, CAL); Mysore Agumbe, cattle shed - Nalur, 3.9.1963, Raghavan 90407 (BSI, CAL); Mysore, Balehelle forest areas, near nala, Raghavan 67845 (BSI).

KERALA: Palghat, Malampuzha river, July 1971, Nair MH acc. No. 89603 & 90664 (MH); Malappuram, Calicut University Campus, 19.10.1982, Geetha 1228 (CALI); Malappuram, Panambra, 30 m, 18.9.1983, Joseph 38516 (CAL, CALI); Malappuram, Thenjippalam, 10.10.1989, Mathew 13152, (CAL).

MAHARASHTRA: Bombay, Salsette, Kannari caves, March 1918, Sedgwick 3715 (BLAT); Bombay, Malad, Quarry hills, 4.9.1955, Shah 4895 (BLAT); Bombay - Suryamal,



1.9.1959, Merchant 1232 (BLAT); Poona, Lonavla, near valwan dam, 18.8.1964, Reddi 98644 (BSI, CAL).

10. *Rotala mexicana* Cham. & Schlecht., *Linnaea* 5: 567. 1830; Koehne in Engl., *Bot. Jahrb.* 1: 150. 1880 & in *Pflanzenr.* 17(4,216): 29. 1903; Blatt. & Hallb., *J. Bombay Nat. Hist. Soc.* 25: 702 1918; Van Leeuwan, *Blumea* 19: 54. 1971; Hara in Hara & Williams, *Enum. Flow. Pl. Nepal* 2: 172. 1979; Cook, *Boissiera* 29: 33. 1979; Joseph & Sivar., *Proc. Indian Acad. Sci. (Plant sci)* 99(3): 187.

Ammannia pygmaea Kurz, *Seem. J. Bot.* 5: 376. 1867 & in *J. As. Soc. Bengal* 11(2): 55. 1871; Clarke in Hook. f., *Fl. Brit. India* 2: 568. 1879; Prain, *Bengal Pls.* 1: 500. 1903; Duthie, *Fl. Upper Gang. Plain* 1: 349. 1903; Haines, *Bot. Bihar & Orissa* 3: 378. 1922; Vasudevan & Nambiar, *J. Bombay Nat. Hist. Soc.* 63: 784. 1967.

Ammannia mexicana (Cham. & Schlecht.) Baillon, *Hist. Pl. Madag. Atl. t.* 363. 1895.

Rotala pygmaea (Kurz) Rajagopal & Ramayya, *Kew Bull.* 23: 465. 1969.

Rotala verticillaris sensu Hiern in Oliver, Fl. Trop. Africa 2: 467. 1871, non L. 1771.

Hoshiarpuria minutiflora Hajra, Daniel & Philcox, Kew Bull. 40(3): 607. 1985; Philcox, Kew. Bull. 41(2): 432. 1986.

Aquatic or amphibious annual erect or prostrate herbs, tuft forming, profusely branched; branches slender, quadrangular. Leaves in whorls of 3-5 or decussate, sessile, cuneate at base, obtuse or bimucronulate at apex, dimorphic; submerged leaves c. 13 x 1 mm, linear; aerial leaves c. 5 x 1 mm, linear-lanceolate or oblong. Flowers monomorphic, sessile, solitary; bracteoles 2, as long as or shorter than calyx tube. Calyx tube c. 0.5 mm long, subglobose, pink, lobes (-3) 4 (-5), c. 0.5 mm long, acutely triangular, appendages absent. Petals absent. Stamens 2, rarely 3 or 4, inserted near the base of calyx tube; anthers included. Ovary c. 0.5 mm across, globose, imperfectly trilocular; style less than 0.3 mm; stigma capitate. Capsule c. 0.75 mm across, globose, 3-valved. slightly exceeding calyx lobes. Seeds 10-15 per capsule, c. 0.3 mm long, semi-obovate, smooth, black (Fig. 13).

Type: Mexico, prope Hacienda de la Laguna, Oct., Schide & Deppe 566 (Holo. - HAL; iso. - LE, MO)

Fig. 12. Rotala malampuzhensis R.V. Nair ex C.D.K. Cook-  
A few plants in a closer view

Fig. 13. Habit of Rotala mexicana Cham. & Schlecht. -  
Field view.



Fls. & Frts. : August - November

Ecology: Growing in shallow water or moist open grounds during rainy season.

Distribution: INDIA: Jammu & Kashmir, Punjab, Uttar Pradesh, Bihar, West Bengal, Sikkim, Meghalaya, Orissa, Madhya Pradesh, Rajasthan, Andhra Pradesh, Karnataka, Kerala; Through out the warmer part of the world except N.E. Africa, Arabia and Pacific Islands (Map 12).

Palynology: P = 18-22  $\mu$ m, E = 12-16  $\mu$ m, P/E ratio = 1.1-1.9, grains minutae, spheroid or prolate; pseudocolpi absent; pores<sub>+</sub> projected, oval; amb triangular; sexine grandular-reticulate (Panigrahi, 1979).

Notes: 1. R. mexicana Cham. & Schlecht. is a widespread and highly variable species. Cook (1979) treated the variations within the species in considerable details for the whole world. In India two growth forms are met with, one form growing on wet ground has tuft forming stems which are prostrate and creeping. This form found commonly and frequently called as R. pygmaea, the second form grows submerged with erect stems which are brach<sub>e</sub>d below and simple above.

(2) Hajra, Daniel and Philcox in Kew Bull. 40(3): 607. 1985 described a new genus and species from Punjab, India, namely Hoshiarpuria minutiflora under the family Scrophulariaceae. Later, Philcox in Kew Bull. 41 (2): 432. 1986, correctly palced the plant in its own taxa, Rotala mexicana.

Specimens examined:

ANDHRA PRADESH: Kurnool, Ramanapenta - Gundlabrahmeswaram, 650 m, 25.10.1964, Ellis 22196 (MH); Hyderabad, Osmania University Campus, 400 m 23.9.1967, Rajagopal 352 (CAL).

BIHAR: Sahebganj, Rajmahal hills, October 1870, Kurz s.n. (CAL); Chota Nagpur, Parasnath, 17.10.1883, Clarke 33811 (CAL); Hazaribagh, 12.9.1896, Prain s.n. (CAL).

KARNATAKA: N. Kanara, Kadra, 5.10.1885, Talbot 1317 (CAL, DD).

KERALA: Calicut, Olavanna, 8.9.1985, Joseph 39342 (CALI); Malappuram, chettippadi, 10.10.1986, Mathew 13157 (CAL).

MADHYA PRADESH: Satna town, 22.9.1959, Sebastine 8928 (MH).

MEGHALAYA: Khassia, 650 m, Hooker & Thomson s.n. (CAL).

ORISSA: Keonjhar, 900 m, 1.10.1946, Mooney 2760 (DD);  
Mahanadi, 4.12.1957, without collector, CAL Acc.  
No. 175858 (CAL).

PUNJAB: Hoshiarpur, Mukerian, on pathankot road, 17.9.1979,  
Daniel 67502 (BSD).

RAJASTAN: Rajputana, Mount Abu, Salgaon, 1200 m, January  
1918, Sedgwick 3447 (BLAT).

SIKKIM: Labhath, c. 2500 m, 17.10.1909, Ribu & Rhomoo 2637  
(CAL).

UTTAR PRADESH: Dehra Dun, Lachiwala, 25.9.1927, Sankar s.n.  
(DD); Dehra Dun Lachmanshid, 27.10.1961, Bhattacharya  
17997 (BSD); Sahasradhara, 8.9.1964, Malhotra 34813  
(BSD); Bahraich, Dharampur, 20.11.1964, Panigrahi &  
Misra 6452 (CAL); Jhikala road, corbett National park,  
25.11.1972, Janardhanan 51214 (BSD); Pithoragarh,  
Didihat Narain Nagar, 1800 m, 30.9.1975, Arora 56667  
(BSD); Saharanpur, Laksar, September 1985, Murty & Geol  
1904 (BSD).

WEST BENGAL: Howrah, Indian Botanic Garden, August 1857, Kurz s.n. (CAL); North Bengal, between Titalya and Silligore, 27.10.1868, Kurz s.n. (CAL); North Bengal, 28.10.1868, Kurz s.n. (CAL).

11. *Rotala occultiflora* Koehne in Engl., Bot. Jahrb. 1: 152. 1800 & in Pflanzenr. 17 (4, 216): 30. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 705. 1918; Gamble, Fl. Pres. Madras 508. 1919; Santapau, Fl. Khandala 98. 1967; Cook, Boissiera 29: 41. 1989; Joseph & Sivar., Proc. Indian Acad. Sci. (plant Sci.) 99(3): 191. 1989.

R. occultiflora Var. leichhardtii Koehne, Bot. Jahrb. 4: 387. 1883.

Amphibious annual herbs. Stems creeping and branching below, erect above, erect part 1.5-10 cm long, trigonous, red or greenish white. Leaves in whorls of 3 or lowest ones opposite, 2.5-12 x 0.3-1 mm, linear, cuneate to dilated or boat-shaped at base, obtuse or bifid at apex, midrib prominent on lower side, recurved. Flowers monomorphic, sessile, solitary in axils of bracts. Bracts 2-9 mm, obspathulate, base dilated and partly covering bracteoles



and flowers, bifid at apex. Bracteoles c. 6 mm long, linear-lanceolate or obspathulate, dilated at base, bifid at apex, completely covering flower from both sides. Calyx tube c. 1 mm long, sub-urceolate, transparent, disintegrating at fruit; lobes 5, c. 0.5 mm long, triangular, appendages absent. Petals absent. Stamens 3 (-2), inserted near the base of calyx tube; anthers included. Ovary c. 1 mm long, ellipsoidal, trilocular; style inconspicuous; stigma capitate. Capsule c. 1.5 mm long, ellipsoidal, 3-valved, exceeding calyx. Seeds c. 0.5 mm long, 10-15 per capsule, semi-ellipsoidal, black (Fig. 14).

Type: India, Malabar, Concan, Laws, Hooker f. & Thomson s.n. (Holo.- K, Photo CAL\*; iso. - CAL\*, L).

Fls. & Frts.: August - January

Distribution: INDIA: Maharashtra, Gao, Karnataka, Kerala; AUSTRALIA (Map 12).

Notes: (1) R. occultiflora Koehne resembles R. mexicana but differs in having large bracteoles with dilated base which enclose the flower; sub-urceolate, transparent calyx tube; ellipsoidal capsule which exceed the calyx. In R. mexicana, the bracteoles are short, narrow and as long as or

Fig. 14. Habit of Rotala occultiflora Koehne.

Fig. 15. Habit of Rotala rosea(Poiret) C.D.K. Cook et Hara-  
Field view



shorter than the calyx tube; calyx tube sub-globose; capsule globose and included within the calyx tube.

(2) R. occultiflora show a high degree of variation in its vegetative parts. The habit of the plant varies from slender stemmed plants of 1.5 cm long to stouter stemmed ones upto 10 cm long. Leaf varies from linear, ovate to obspathulate with cuneate or dilated to boat shaped base. Bracteoles are linear-lanceolate or obspathulate.

Due to its high degree of variation in its vegetative parts, recognition of infraspecific taxa based on vegetative characters is not supportable. Hence, the variety leichhardtii recognised by Koehne (1883) is not considered.

(3) Panigrahi et al. in Bull. Bot. Surv. India 11 (1&2): 104. 1969 and later on Raizada in Suppl. Fl. Upper Gangetic Plain 71. 1976 reported R. occultiflora Koehne from Bahraich district in Uttar Pradesh and cited Panigrahi 6452 as voucher specimen. The present author critically studied the above mentioned specimen and found out that it is not R. occultiflora Koehne but R. mexicana Cham. & Schlecht., a widespread species.

Specimens examined:

GOA: Ponda, 13.9.1965, Cherian 106604 (BSI).

KARNATAKA: Malabar, concan, Laws, Hooker f. & Thomson s.n. (CAL); N. Kanara, Yellapore, 7.10.1884, Talbot 1036 (BSI, CAL, DD); N. Kanara, Yellapore, 21.10.1884, Talbot 1332 (BSI, CAL, DD); Shimoga, October 1908, Meebold 10281 (CAL).

KERALA: Malappuram, Tenjippalam, 5.10.1970, Sivarajan 588 (CALI); Malappuram, Calicut University Campus, marshy field, 16.8.1984, Joseph 39019 (CALI); Malappuram, Calicut University Campus, 10.10.1989, Mathew 13153 (CAL).

MAHARASHTRA: Bombay, Sion, January 1918, Sedgwick 3446 (BLAT); Poona, Lonavla, Valwandam site, 9.10.1964, Reddy 98645 (BSI, CAL); Poona, Ambavne, Atvanka Dangarwada, 21.11.1964, Reddy 100931 (BSI, CAL); Thana, Washalu range, Ajoba hill, 16.10.1967, Billore 111920 (BSI, CAL); Thana, Manor range, Asheri, 29.10.1967, Billore 116664 (CAL); Thana, Dahisar range, Ganja R.F., 15.9.1968, Billore 116703 (CAL).

12. *Rotala ritchiei* (Clarke) Koehne in Engl., Bot. Jahrb. 4: 386. 1883 & in Pflanzenr. 17 (4, 216): 36. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 709. 1918; Janardhanan, Bull. Bot. Surv. India 21: 230. 1979; Cook, Boissiera 29: 71. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 192. 1989. Mathew & Ahmed., Bull. Bot. Surv. India 31 (1-4): 161. 1989 (1992).

Ammannia ritchiei Clarke in Hook. f., Fl. Brit. India 2: 566. 1879; Cooke, Fl. Pres. Bombay 1: 508. 1903.

Aquatic or amphibious, annual herbs. Stems upto 35 cm long, pale pinkish, slender, branched, tetragonous, creeping or floating below with flowering branch apices emerging out of water. Leaves decussate, 1-3 x 0.3-0.9 cm, elliptic-oblong to obovate, obtuse or rounded at apex, narrowed towards base. Flowers monomorphic, solitary in the axils of bractiform leaves, shortly pedicellate; bracteoles 2, c. 0.5 mm long, subulate. Calyx tube c. 2 mm long, cylindrical; lobes 4, shallowly triangular; appendages longer than lobes. Petals 4, c. 1 mm long, obovate or ovate, exceeding the calyx lobes, rose. Stamens 4, inserted below the middle of calyx tube; anthers included. Ovary c. 1.5 mm long, ellipsoidal; style very short; stigma capitate, minutely

papillose. Capsule c. 3 mm long, ellipsoidal, 4-valved. Seeds elliptical, c. 0.8 mm long.

Type: India, Karnataka, Belgaum, Oct. Ritchie 1184 (Holo.-K, Photo. CAL\*).

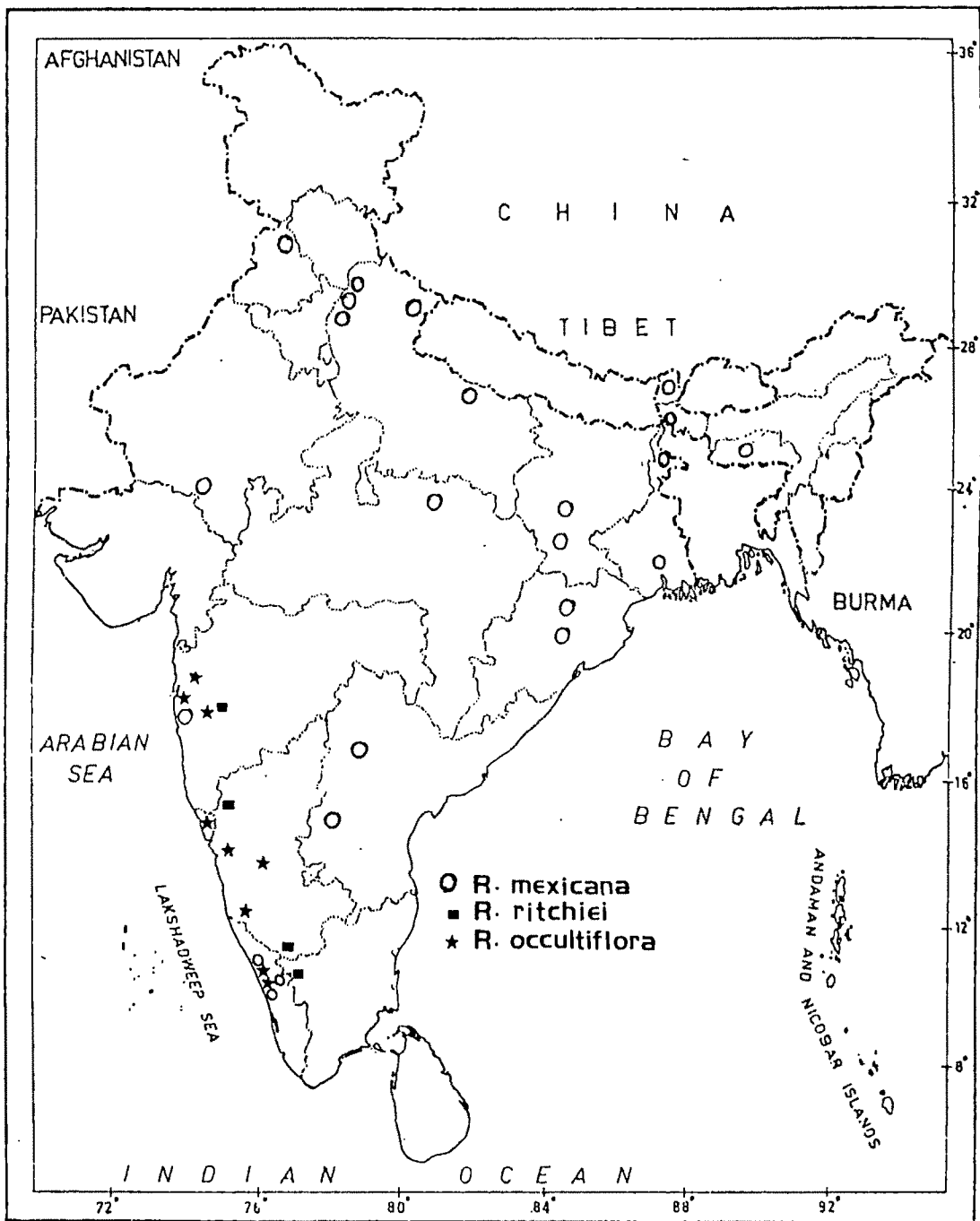
Fls. & Frts. August-February

Ecology: An aquatic plant growing along the shallow margins of fresh water ponds with stem creeping and rooting amongst floating weeds and tips of flowering branches emerging out of water

Distribution: INDIA, Maharashtra, Karnataka, Tamil Nadu (Map 12).

Notes: R. ritchiei has already been included in the Indian Red Data Book (Nayar & Shastry, 1987). This has been originally described by Clarke based on Ritchie's collections from Belgaum, Karnataka. After a lapse of 100 years Janardhanan (1979) reported it from Pune, Maharashtra. According to available literature, this taxon is represented by the above mentioned two collections.

During the present study, the author examined specimens of this taxon collected from Mysore (Karnataka) and Coimbatore (Tamil Nadu) which are deposited in DD and CAL



Map 12. Distribution of *Rotala mexicana*, *R. ritchiei* and *R. occultiflora* in India.



respectively. Both these collections were wrongly identified and unnoticed by earlier workers. The correct identity of these two collections thus extends the distribution of R. ritchiei from Northern Western ghats to Southern Western ghats as well.

Specimens examined:

KARNATAKA Belgaum, October, Ritchie 1184 (K); Mysore, Kataribetta, Billigiri Rangan Hills, September 1938, Barnes 2211 (DD).

MAHARASHTRA: Pune, Chakan-Alandi Road, 16.8.1966, Janardhanan 68579 (BSI, BSD); *ibid.*, 8.10.1966, Janardhanan 92984 (BSI).

TAMIL NADU: Coimbatore, Devarakerai, 1580 m, 13.2.1907, Fischer 1419 (CAL).

13. Rotala rosea (Poiret) C.D.K. Cook et Hara, Enum. Flow. Pl. Nepal 2: 173. 1979; Cook, Boissiera 29: 86. 1979; Joseph & Sivar.; Proc. Indian Acad. Sci. (Plant Sci.) Vol. 99(3): 192. 1989.

Ammannia rosea Poiret in Lamarck, Ency. Meth. Bot. Suppl. 1: 329. 1810; DC., Prod. 3: 80. 1828.

Ammannia pentandra Roxb., Fl. Ind. 1: 448. 1820; Dc., Prod. 3: 79. 1828; Wight & Arn., Prod. Fl. Penin. Ind. Or. 305. 1834; Clarke in Hook. f., Fl. Brit. India 2: 568. 1879 p.p.; Cooke, Fl. Pres. Bombay 1: 507. 1903 p.p.; Duthie, Fl. Upp. Gang. Pl. 1: 350. 1903 p.p., Prain, Bengal Pls. 1: 500. 1903 p.p.; Haines, Bot. Bih. & Or. 2: 235. 1921.

Rotala pentandra (Roxb.) Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25. 707. 1988 p.p., Van Leeuwen, Blumea 19: 55. 1971.

Ammannia leptopetala Blume, Mus. Bot. Lugd. Bat. 2: 134. 1856.

Rotala leptopetala (Blume) Koehne in Engl., Bot. Jahrb. 1: 162. 1880 & in Engl., Pflanzenr. 17 (4, 216): 23. 1903; Gamble, Fl. Pres. Madras 1:508. 1919; Hara, Fl. East. Himalaya 218. 1966; Saldanha et al., Fl. Hassan Dist. 271. 1976; Kulkarni & Singh; Bull. Bot. Surv. India 21 (1-4); 213. 1979.

Amphibious or terrestrial, annual herbs. Stem 5-30 cm long, creeping and rooting below and erect above, simple or branched, tetragonous. Leaves decussate, 5-25 x 2-5 mm, oblong linear-oblong or linear-lanceolate, cuneate or

obtuse at base, obtuse to acute or rarely truncate or bifid at apex, margin entire, membranaceous. Flowers sessile, solitary in axils of bracts, monomorphic, pentamerous. Bracteoles 2, c. 0.5-1 mm long, as long as or shorter than calyx tube. Calyx tube campanulate, c. 1 mm long, lobes 5, 0.25-4 mm long, acuminate, appendages 5, acuminate, caducous. Petals 5, 0.25-0.5 mm, obovate or rhomboid, caducous. Stamens 5, filaments attached little below the middle of calyx tube, anthers reaching up to the mouth of calyx tube. Ovary c. 1 mm long, globose, trilocular, style insignificant; stigma capitate. Capsule c. 2 mm across, globose, reddish, exceeding calyx tube, 3-valved. Seeds semi-ovoid, 0.3 mm long, brownish (Fig.15).

Type: Indes orientales, herb. Desfontaines (holo. FL)

Fls. & Frts. : August - February.

Distribution: INDIA: Punjab (Cook, 1979), Uttar Pradesh, Bihar, West Bengal, Assam, Meghalaya, Orissa, Madhya Pradesh, Rajasthan (Cook, 1979), Maharashtra, Andhra Pradesh, Tami Nadu, Karnataka, Kerala; BANGLADESH; BURMA; SRI LANKA; MALAYSIA; THAILAND, INDONESIA, PHILIPPINES; CHINA; TAIWAN; KOREA; JAPAN. (Map 13).

Notes: (1) There exists a great deal of disagreement among the earlier workers regarding the circumscription of this species. Clarke (1979) have considered R. rosea as conspecific to R. rubra, R. densiflora, R. illecebroides and R. fimbriata under the binomial Ammannia pentandra Roxb. Koehne (1880) treated R. rubra (as R. alata), R. densiflora, R. rosea (as R. leptopetala) R. illecebroides, and R. fimbriata as distinct species. Blatter & Hallberg (1918) have considered R. rosea as conspecific to R. illecebroides and R. densiflora under the binomial R. pentandra, a new combination, based on Ammannia pentandra Roxb. They considered R. fimbriata as distinct species. Van Leeuwen (1977) is of the opinion that R. rosea (as R. pentandra) and R. densiflora are distinct.

(2) It differs from R. densiflora by monomorphic leaves with cuneate to obtuse leaf bases; bracteoles subulate as long as the calyx tube; petals smaller and caducous, inconspicuous style and exserted capsule.

(3) C.D.K. Cook proposed the name R. rosea as "combination nova" in his revisionary work of Rotala published in Boissiera 29: 86. July 1979. Consequently prior to Cook's publication Hara in his Enum. Fl. Pl. Nepal Vol. 2 published in June 1979 proposed R. rosea as new combination

by giving authority to Cook. According to rule of priority the citation of this species must be as R. rosea (Poiret) C.D.K. Cook et Hara, Enum. Flow. Pl. Nepal 2: 173. 1979.

Specimens examined:

ANDHARA PRADESH: Warangal, Pakhal, 290 m, 25.2.1963, Henry 15914 (MH); Chittoor, Talakona R.F., 650 m, 5.1.1976, SubbaRao 46967 (CAL, MH); S. Arcot, Marakkanam, 50 m, 9.9.1977, Ramamurthy 51135 (MH).

ASSAM: Guwahati, along Railway line, 13.3.1962, Panigrahi 27826 (CAL).

BIHAR: Chota Nagpore, Maunbhoom, Govindpur, 300 m, 27.9.1873, Clarke 20632 (CAL).

GOA: Vasco, navy office plateau, 20.8.1963, Kanodia 89395 (BSI); Cumbani, 6.10.1970, Singh 125063 (BSI).

KARNATAKA: N. Kanara. Sidashyagud, 1.8.1883, Talbot 586 (BSI, CAL, DD); Mysore & Carnatic, without locatilty, Thomson s.n. (CAL); Mysore, Nandi Droog, 26.12.1911, Anstead M 116 (MH).

KERALA: Cannannore, Kannothe, 8.12.1913, without collector 9513 (MH); Trichur, Guruvayur, 10 m. 6.9.1976, Ramamurthy 47653 (CAL, MH); Cannanore, Tellicherry 50 m, 17.8.1978, Ramachandran 63980 (CAL, MH); Cannanore, Panur - Elangad, 21.12.1979, Ramachandran 63980 (CAL, MH); Cannanore, Panur - Elangad, 21.12.1979, Ramachandran 65367 (CAL, MH); Malappuram, Chettippadi, 10.10.1989, Mathew 13156 (CAL).

MADHYA PRADESH: Satna, Sankarghat hills, 450 m, 21.9.1959, Sebastine 8914 (CAL, MH); Bilaspur, Kota - Bilaspur Road, 29.10.1970, Panigrahi 13046 (CAL).

MAHARASHTRA: Bhandara, Sarvanunager, 14.9.1963, Rao 91635 (BSI); Thana, Dalrifar range, Tak-Mak hill, 600 m, 16.9.1968, Billore 116725 (BSI); Chandrapur, Tarvba, 25.2.1971, Wadhwa 133439 (BSI).

MEGHALAYA: Khasia, Griffith 2311 (CAL); Khasia, Masters s.n. (CAL).

ORISSA: Ganjam, Naupada, January 1890, Gamble 21603 (CAL, DD).

TAMIL NADU: Madras, 26.1.1899, Barber 99 (MH); Madras, 1.2.1899, Barber 135 (MH); Madura, Pulney Hills, Tandikudi, 750 m, 28.5.1899, Bourne s.n. (CAL); Madura, Pulney Hills, 750 m, January 1916, Montand 1675 (CAL); Madras, Elliots Bunglow, Red Hills, 30.3.1930, Barnes s.n. (DD); N. Arcot, Elageres, December 1939, Barnes s.n. (DD); Shevaroy, Green Hills, January 1941, Barnes s.n. (DD); S. Arcot, Annamalainagar, 31.1.1958, Sebastine 5228 (CAL, MH); Salem, Yercaud, Balmadier Estate, 1666 m, 18.12.1958, Subramanyam 7539 (MH); Nilgiri, Ebanad to Sirur, 1650 m, 9.9.1970, Subbarao 36585 (MH); S. Arcot, Marakkanam, 50 m, 9.9.1977, Ramamurthy 51135 (CAL, MH); S.Arcot, Chidambaram, Samiyarpattai, 27.1.1979, Venugopal & Jayaseelan 21277 (CAL); Tiruchirappalli, Thuraiyur, Pachaimalais, 900 m, 16.3.1976, Matthew 12309 (CAL); Dharmapuri, Harur, Chitteri Hills, 1200 m, 11.1.1979, Venugopal & Jayaseelan 20800 (CAL).

UTTAR PRADESH: Hamirpur, Mahaba 25.9.1961, Bhattacharya 17766 (BSD); Saharanpur, Beharigarh, February 1986, Murty & Goel 1999 (BSD).

WEST BENGAL: Lower Bengal, 1867, Kurz s.n. (CAL); Hooghly, Goghat, August 1902, Husain s.n. (CAL); Howrah, Sibpur,

I.B.G., 20.7.1958, Chatterjee 847 (CAL); Hooghly, Arambagh, 22.11.1961, Hajra 105 (CAL); Howrah, Jagatballarpur, 18.12.1963, Bennet 488 (CAL); Purulia, Matha, 11.9.1964, Malick 14 (CAL); Cooch Behar, Bishnupur, 13.9.1964, Sanyal 278 (CAL); Birbhum, Tarapita, 9.10.1968, Basak 883 (CAL); Birbhum, Nalhati, 20.10.1970, Basak 1515 (CAL); Midnapur, Kanyaduba, 21.11.1975, Maji 2058 (CAL).

14. *Rotala rotundifolia* (Buch. - Ham. ex Roxb.) Koehne in Engl., Bot. Jahrb. 1: 175. 1880 & in Pflanzenr. 17 (4, 216): 41. 1903; Blatt. & Hall., J. Bombay Nat. Hist. Soc. 25: 718. 1918; Gamble, Fl. Pres. Madras 509. 1919; Hara, Fl. East. Himalaya 218. 1966; Hara in Hara & Williams, Enum. Flow. Pl. Nepal 2: 173. 1969; Cook, Boissiera 29: 49. 1979; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 193. 1989.

Ammannia rotundifolia Buch. - Ham. ex Roxb., Fl. Indica 1 (ed. 1): 446. 1820; Don, Prodr. Fl. Nepal 220. 1825; DC. Prod. 3: 79. 1828; Wight & Arn., Prod. Fl. Penin. Ind. Or. 1: 306. 1834; Clarke in Hook. f., Fl. Brit. India 2: 566. 1879 p.p.; Cooke, Fl. Pres. Bombay 1: 508. 1903; Duthie, Fl. Upper Gang. Plain 1: 349. 1903;



Prain, Bengal Pls. 1: 500. 1903; Haines, Bot. Bihar & Orissa 3: 377. 1922; Kanjilal, Fl. Assam 2: 316. 1938.

Ameletia rotundifolia (Buch. - Ham. ex Roxb.) Dalz. & Gibs., Bombay Fl. 96. 1861, non Wight 1840.

Ammannia subspicata Benth. in Hook., London J. Bot. 1: 484. 1842.

Ameletia subspicata (Benth. ) Benth. in Hook., Bot. Kew Gard. Miscell. 4: 81. 1852.

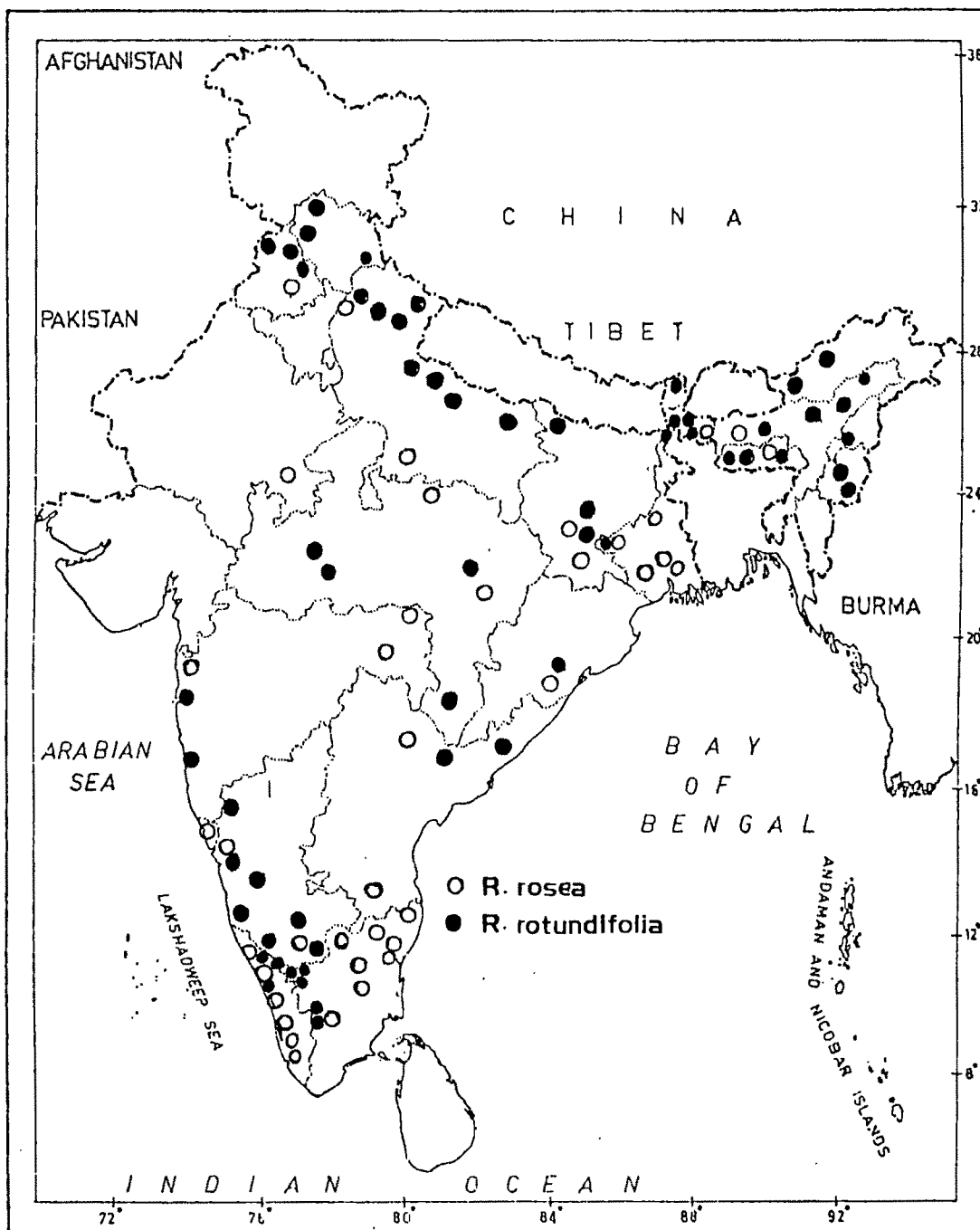
Amphibious annual or perennial herbs. Stems creeping with numerous erect branches or floating, 5-35 cm long, woody below, 4-angled above. Leaves opposite decussate, sessile or subsessile; submerged leaves up to 5 x 3 mm, linear-oblong, obtuse at apex, membranous; aerial leaves 4-22 x 3-20 mm, obovate-orbicular, rarely ovate, obtuse or rounded at apex, cuneate or subcordate at base, greenish red, nerves distinct. Inflorescences terminal, simple or branched, pedunculate, spike, c. 8 cm; Bracts 1-4 x 0.75-2.5 mm, ovate. Flowers monomorphic, subsessile, tetramerous; bracteoles 2, c. 1 mm long, linear-lanceolate, almost equalling the calyx tube. Calyx tube c. 1.5 mm long,

campanulate, 4-nerved, pink; lobes 4, less than 1 mm long, triangular, acute; appendages absent. Petals 4, c. 3 x 1.5 mm, obovate or suborbicular, pink. Stamens 4, inserted at the base of calyx tube; filaments c. 1.5 mm long; anthers included. Ovary c. 1 mm long, globose, 4-loculed; style c. 0.5 mm long; stigma broadly capitate, massive, level with anthers. Capsules c. 1.5 mm across, globose, 4-valved. Seeds c. 0.5 mm long, ellipsoid, brownish yellow (Fig. 16 & Text Fig. 14).

Type: India, West Bengal, 1797, Roxburgh. Based on plants cultivated at Calcutta botanic garden, which were sent from Lukshmeepora and Malda. This specimen is not present in any of the herbarium.

Fls. & Frts. : Throughout the year.

Distribution: INDIA: Jammu & Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, Bihar, West Bengal, Sikkim, Arunachal Pradesh, Assam, Nagaland, Manipur, Meghalaya, Tripura, Orissa, Madhya Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala; BANGLADESH; NEPAL; BURMA; THAILAND; LAOS; VIETNAM; CHINA; HONG-KONG; TAIWAN; JAPAN. (Map 13).



Map 13. Distribution of *Rotala rosea* and *R. rotundifolia* in India.

Fig. 16. Type photograph of Rotala rotundifolia(Buch. - Ham  
ex Roxb.) Koehne.



BSI Neg  
5117



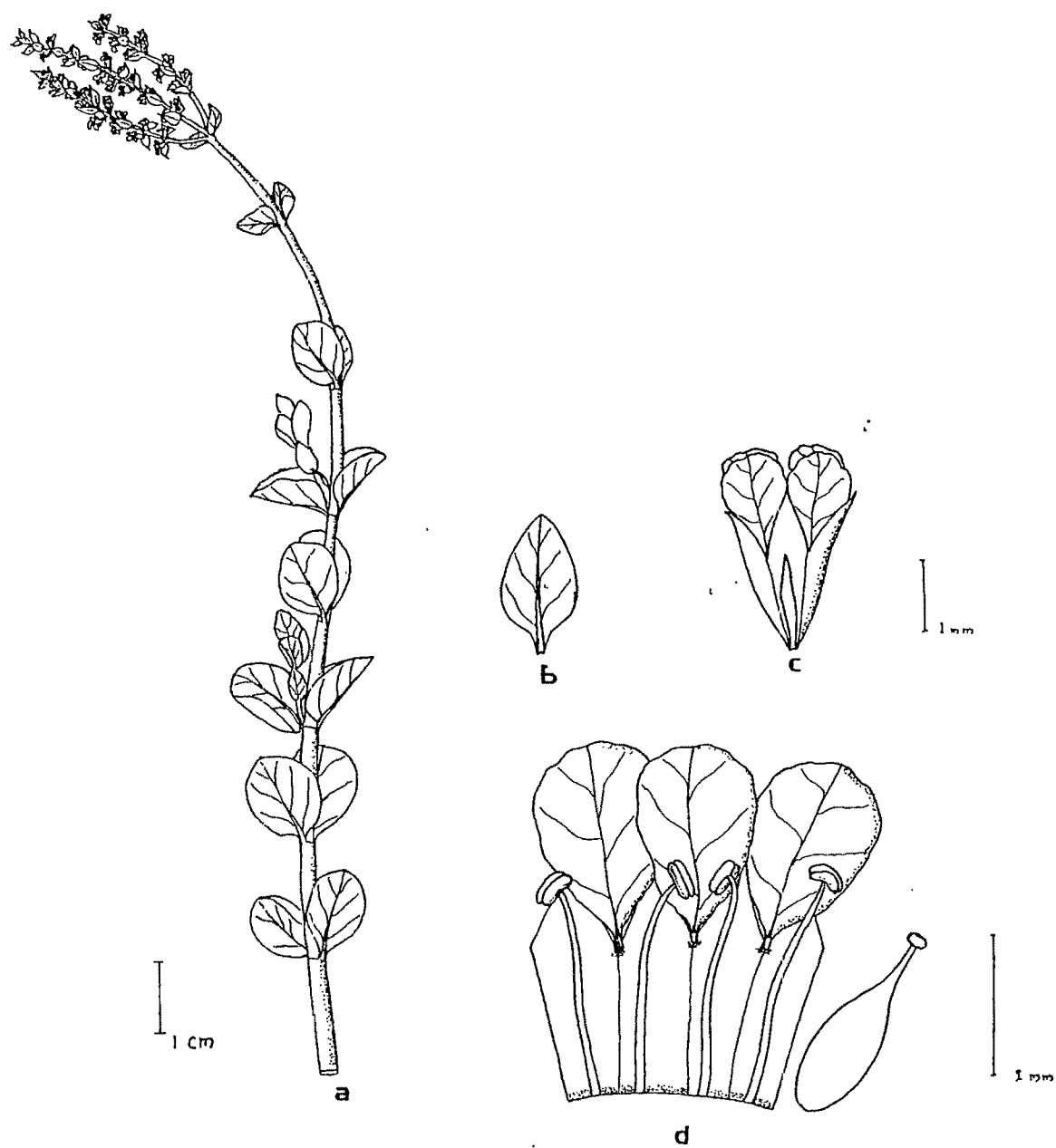
Type Specimen

*Reynoldsia rotundifolia*, Burk. & Hauss.

16

Text Fig. 14. Rotala rotundifolia (Buch. Ham. ex Roxb)  
Koehne

- a. Habit
- b. Bract
- c. Flower
- d. Flower dissection



Text Fig. 14

Specimens examined:

ANDHRA PRADESH: Visakapatnam, Araku Valley, 8.3.1953  
Mudaliar s.n. (MH); Araku, Jolaput, 950 m, 19.5.1964,  
Subbarao 19698 (MH); Kilagada, 900 m, 9.3.1965,  
Subbarao 22578 (MH); Tamarapilli, Minumuluru, 1125 m,  
 13.4.1976, Subbarao 47315 (CAL, MH).

ARUNACHAL PRADESH: Kameng, Dirang-Dong, 1783 m, 17.5.1957,  
Rolla 7552 (CAL); Mairong to Nongkhlaw, 15.6.1958,  
Panigrahi 16156 (CAL).

ASSAM: Lower Assam, April 1876, Kurz 27 (CAL); Assam, 1880,  
Simons s.n. (CAL); Sibsagar, Dumar Dullang, April 1895,  
Watt 10495 (CAL); Golaghat, 15.3.1896, king 51 (CAL);  
 Kamrup, Garo hills, January 1903, Marten s.n. (CAL);  
 Lakhimpur, Talap, Gammie 159 (CAL); Tezpur, 4.2.1944,  
Bore 18044 (DD).

BIHAR: Chota Nagpur, Paresnath, March 1887, Campbell 27  
 (CAL); Champaran, Manguraha forests, 11.4.1963,  
Thothathri 10004 (CAL); Hazaribagh, Bankheta,  
 15.11.1964, Kanodia 1254 (CAL); Hazaribag, Koderma,  
 2.3.1976, Banerjee 3214 (CAL); Chota Nagpur, Baragaon,  
 9.5.1978, Wood s.n. (CAL).



HIMACHAL PRADESH: Kangra, 1853, Jameson s.n. (DD); Chamba, 2.6.1864, Brandis 4295 (CAL, DD); Jons Valley, Jaunsar, 910 m, May 1891, Gamble s.n. (CAL); Kangra, 1200-1520 m, June 1911, Donce 6 (DD).

KARNATAKA: S. Kanara, Karkal, 17.3.1915, Barber 12013 (CAL); Belgaum, Londa, 21.4.1950, Fernandez 1309 (BLAT); Londa, along Belgaum Road, 21.4.1950, Santapau 10851 (BLAT); N. Kanara, Yellapur, Sahrahalli, 26.5.1954, Santapau 18739 (BLAT); Shimoga, Kamangandi, 9.12.1959, Ahuja 65619 (BSI); Mysore, Agumbe, Begur - Balehalli, 8.2.1961, Raghavan 69491 (BSI, CAL); Shimoga, Hulical, Hosnagar, 27.2.1962, Raghavan 79634 (BSI, CAL); Mandya, Shivasamudram, 3.3.1978, Ahamed 308 (CAL); Kodagu (Coorg), Nagerhole, 5.2.1979, Sreenath & Prakash 5984 (CAL).

KERALA: Wynad, 1880, Beddome s.n. (MH); Wynad, Neddikarna to Nedimballi, 14.1.1903, Barber 5623 (MH); Cannanore, Kannothe, 8.12.1913, Barber 9511 (MH); Calicut, Chedaleth, 900 m, 7.2.1964, Ellis 18588 (MH); Cannanore, Pazhasidam site, 150 m, 21.1.1979, Ramachandran 59057 (CAL, MH); Cannanore, Chandanathode, 825 m, 22.2.1979, Ramachandran 61315 (MH); Cannanore, Kannothe, 140 m, 19.3.1980, Ramachandran 66819 (CAL, MH).

MADHYA PRADESH: Saugor, Tinorda, Hirapur, 410 m, 3.3.1960, Subramanyam 10174 (CAL, MH); Bastar, Rooghat, 550 m, 15.2.1961, Balakrishnan & Henry 12140 (CAL, MH); Horangabad, Rorighat, 26.12.1962, Panigrahi 6564 (CAL); Bilaspur, Korba, 17.4.1963, Panigrahi & Arora 8664 (CAL).

MAHARASHTRA: Bombay, Kolaba - Roha, 24.5.1958, Jain 37164 (CAL); Ratnagiri, Way to Ramghat, 1.5.1966, Kulkarni 108539 (BSI).

MANIPUR: Manipur Valley, 600-1216 m, 4.2.1882, Watt 5835 (CAL); Noun, shong Khong Valley, 1180 m, 6.4.1882, Watt 6297 (CAL); Thonbal, 760 m, 16.12.1942, Bor 17200 (DD); Imphal hills, 9.4.1962, Srivastava 811992 (CAL).

MEGHALAYA: Khassia and Jynteah hills, Cherrapungi, July 1878, Gallatly 418 (CAL); Shillong, May 1893, King s.n. (CAL); Garo hills, manieganj, 26.1.1930, Parry 1282 (CAL); shillong, 1275 m, 25.1.1943, Bore 16988 (DD); Shillong, 22.8.1959, Deka 18390 (CAL).

NAGALAND: Kohima, 1520 m, 1.2.1882, Collett 131 (CAL); Kohima, Naga Hills, 912-1824 m, April 1886, Prain s.n. (CAL).

ORISSA: Ganjam, Tiekapalli - Linepada, 23.1.1900, Barber 1223 (MH); Gurguria, Genabil, 16.2.1958, Panigrahi 12434 (CAL); Panposh, 5.3.1966, Arora 4536 (CAL).

PUNJAB: Pathankot, Aarpur, 8.3.1902, Watt 15208 (CAL); Hoshiarpur, Sahan Nadi, Gagret, 21.3.1902, Watt 15577 (CAL); Hoshiarpur, Gagret, 18.4.1972, Misra 47093 (BSD, CAL).

SIKKIM: Without locality, 2.2.1867, Anderson s.n. (CAL, DD); Rumbhaghora, 8.2.1908, Ribu 460 (CAL); Golma, 14.4.1914, Modds 153 (CAL).

TAMIL NADU: Nilgiri mountains, 1851, Hohenacker 1144 (CAL); Nilgiri, Coonoor, 1520 m, May 1883, Gamble 11640 (CAL); Ooty, 2128 m, August 1885, Gamble 16643 (CAL); Nilgiri, Kotagiri, Kottai combai, 1733 m, 6.1.1957, Subramanyam 1989 (CAL, MH); Nilgiri, Marapalam, 1500 m, 23.3.1957, Sebastine 2583 (CAL, MH); Nilgiri, kunnacombai - Kundha, 2000 m, 16.5.1957, Sebastine 3282 (CAL, MH); Kodaikanal, Pillar rocks, 2000 m, 21.4.1965, Ramamurthy 23339 (MH); Madurai, Kodaikanal, Vattakannal, 1900 m, 18.9.1968, Deb 30991 (MH); Nilgiri, Ooty - Naduvattom, 2150 m, 10.3.1969, Deb 31610 (MH); Nilgiri, Pykara river banks, Pykara, 1975 m, 10.2.1971, Ellis 37913 (MH).

UTTAR PRADESH: Almora, 1834, Jameson s.n. (DD); Saharanpur, 16.3.1843, Jameson s.n. (DD); Dehra Dun, April 1881, Gollan s.n. (CAL); Gorakhpur, Ramgarh, 25.3.1898, Harsuk 21575 (DD); Kheri, Dudhaia, 7.4.1898, Inayat 21575 (DD); Pilibit, marori, 26.5.1898, Harsukh 21575 a (DD); Bahraich, Chukanaddi, 7.4.1900 Inayat 23649 (DD); Dehra Dun, Mathronwala, 27.3.1958, Dakshini 3941 (BSD); Dehra Dun, Rajpur, 940 m, 11.2.1961, Saxena 1634 (DD); Pithoragarh, Kumaon, 10.5.1961, Bhattacharya 15092 (BSD); Pilibit, 24.2.1977, Vohra 58352 (BSD); Tehri, Ghansali 1000 m, 15.3.1979, Goel 6784 (BSD); Pithoragarh, Askot, 16.4.1984, Balodi 75590 (BSD).

WEST BENGAL: Silligoree, January 1873, Gamble 3023 (CAL); Kurseong, Gulma, 15.4.1914, Hussain 153 (CAL); Jalpaiguri, Apalchand, Kathambari, 27.4.1962, Mukherje 3611 (CAL); Purulia, Hatinda forest, 21.7.1968, Malick 359 (CAL); Jalpaiguri, Phuljhora, Apalchand, 22.2.1975, Sikdar 65 (CAL).

15. *Rotala rubra* (Buch. - Ham. Ex D. Don) Hara, J. Jap. Bot. 52(7): 197. 1977 & in Enum. Fl. Pl. Nepal 2: 173. 1979; Cook, Boissiera 29: 96. 1979.

Ammannia rubra Buch. - Ham. Ex D. Don, Prodr. Fl. Nepal 220.  
1825; Spreng., Syst. Veg. 4(2): 43. 1827; DC. Prod. 3:  
80. 1828; Wallich Num. List No. 2107. 1829 nom. nud.

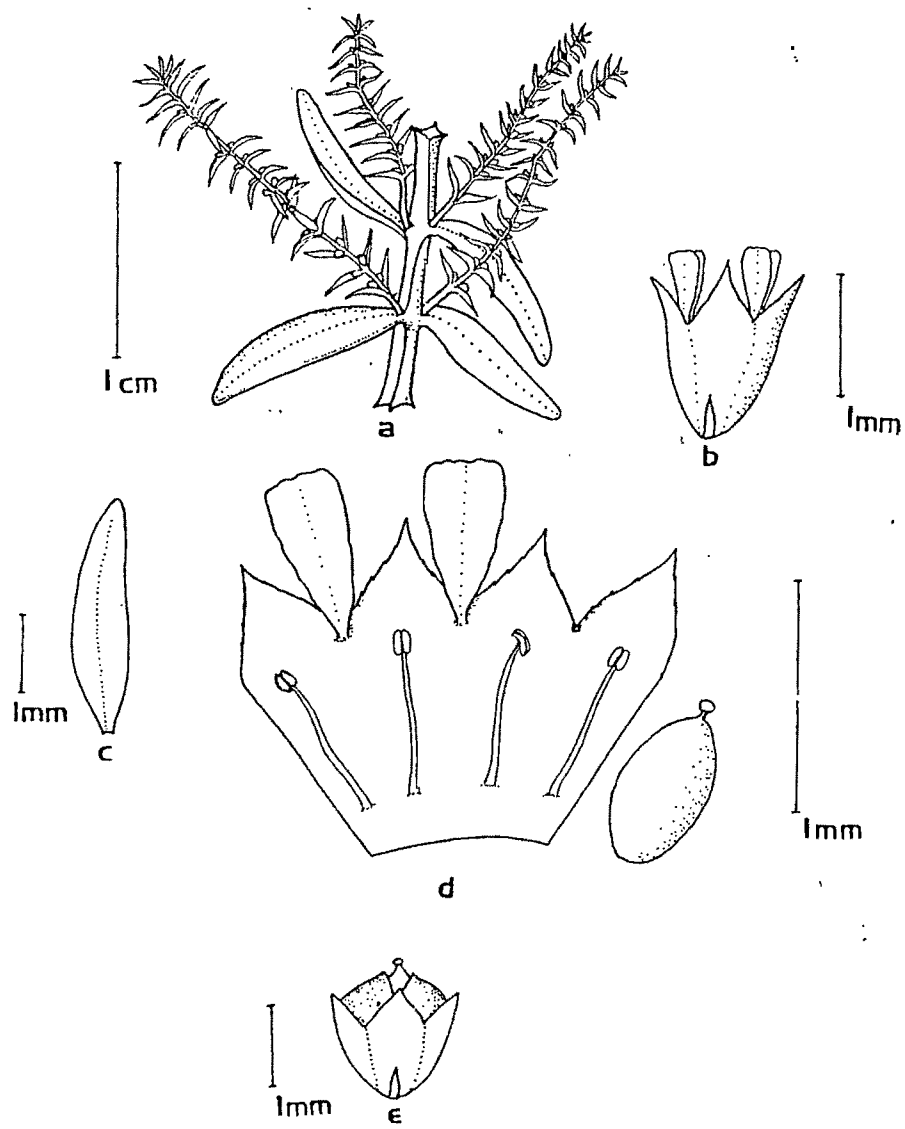
Ammannia pentandra sensu Clarke in Hook. f., Fl. Brit. India  
2: 568. 1879 p.p. non Roxb 1820.

Rotala alata Koehne, Bot. Jahrb. 1: 171. 1880 & in  
Pflanzenr. 17 (4, 216): 40. 1903.

Annual erect herbs. Stems c. 15 cm long, branched, 4-winged; wings whitish, discontinuous which run into the leaf or bract margins at each internode. Leaves decussate, c. 12 x 2.5 mm, ovate to oblong, cuneate at base, obtuse at apex. Flowers monomorphic, sessile solitary in axils of bracts, usually borne on lateral branches and top of the main stem. Bracts leaf like; bracteoles 2, c. 0.3 mm long, inconspicuous. Calyx tube campanulate, c. 1 mm long; lobes 4, c. 0.5 mm long, triangular, acuminate, margin toothed, appendages absent. Petals 4, c. 0.75 mm long, obovate, truncate at apex, margin undulate, equalling or slightly exceeding the calyx lobes, persistent. Stamens 4, c. 0.75 mm long, inserted near the base of calyx tube. Ovary c. 1 x 0.5 mm, subglobose; style minute; stigma capitate. Capsule c. 1 mm across, subglose, 3-valved, exceeding calyx tube. Seeds c. 0.4 mm, suborbicular. (Text Fig. 15).

Text Fig. 15. Rotala rubra (Buch. Ham. ex D.Don) Hara

- a. Habit
- b. Flower
- c. Bract
- d. Flower dissection
- e. Flower with mature capsule



Text Fig. 15

Cook cite Wallich 2107A (G)  
as lectotype

Type: Napaul (Nepal), Hamilton s.n. (Holo. - BM)

Fls. & Frts. : November - January

Distribution: INDIA: West Bengal; NEPAL (Map 13).

Notes: (1) R. rubra (Buch. - Ham. ex D. Don) Hara resembles R. rosea (Poirot) C.D.K. Cook ex Hara and R. cordata Koehne. It differs from R. rosea by its discontinuous wings in the stem and branches; strictly tetramerous flowers; very small bracteoles which are not reaching up to 1/3 the length of calyx tube; and its toothed margins of calyx lobes. From R. cordata Koehne, it differs in having cuneate leaf bases; smaller petals (0.75 mm); capsules which are exceeding the calyx tube and having very short styles.

(2) R. rubra (Buch. - Ham. ex D. Don) Hara is being reported here for the first time from India.

Specimens examined:

WEST BENGAL: Siliguri, November 1878, Without Collector,  
Acc. No. 175889 A, mixed with R. rosea (CAL).

NEPAL: Without precise locality, 1821, Wallich 2107 (CAL).



16. *Rotala serpyllifolia* (Roth) Bremak., Acta. Bot. Neerl. 3: 149. 1954; Cook, Boissiera 29: 61. 1979; Parmer in Shetty & Singh, Fl. Rajasthan 1: 325. 1987; Joseph & Sivar., Proc. Indian Acad. Sci. (Plant Sci.) 99. 194. 1989.

Micranthus serpyllifolius Roth, Nov. Pl. Sp. 282. 1821.

Ameletia tenuis Wight, Ic. Pl. Ind. or. 1: 13. t. 2578. 1840; Dalz. & Gibs., Bomay Fl. 96. 1861.

Ammannia tenuis (Wight) Clarke in Hook. f., Fl. Brit. India 2: 567. 1879; Cooke, Fl. Pres. Bombay 506. 1903; Duthie, Fl. Upper Gang. Pl. 1: 349. 1903.

Rotala tenuis (Wight) Koehne in Engl., Bot. Jahrb. 1: 177. 1880 & in Pflanzenr. 17 (4, 216): 42. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 720. 1918.

Aquatic or amphibious annual herbs. Stems 5-30 cm long, simple or branched, creeping below, erect above, slender, terete, reddish. Leaves simple, decussate, sessile, 2-15 x 1-5 mm, submerged leaves linear or orbicular, aerial leaves broadly ovate to elliptic, cuneate at base, acute or obtuse at apex. Inflorescences terminal, pedunculate condensed spike, c. 5 cm long. Flowers monomorphic, sessile, solitary

in axils of bracts. Bracts 2-3.5 mm long, ovate to lanceolate; bracteoles 2, 1.5-3 mm long, linear-lanceolate, shorter than calyx tube. Calyx tube c. 3.5 mm long, sub-cylindrical, constricted below the mouth, lobes 4, less than 0.5 mm long, triangular, acute, accessory lobes absent. Petals 4, c. 0.5 mm long, obovate, pink. Stamens 4, inserted at the middle of calyx tube; anthers included. Ovary 1-1.5 mm long, ellipsoidal, stipitate, bilocular; style c. 1 mm long; stigma capitate, included. Capsule 1.5-2 mm long, ellipsoidal, 2-valved, included with in calyx tube. Seeds c. 0.7 mm long, elliptic, brownish yellow (Text Fig.16).

Type: Herb. Ind. Or., Heyne (iso.- L)

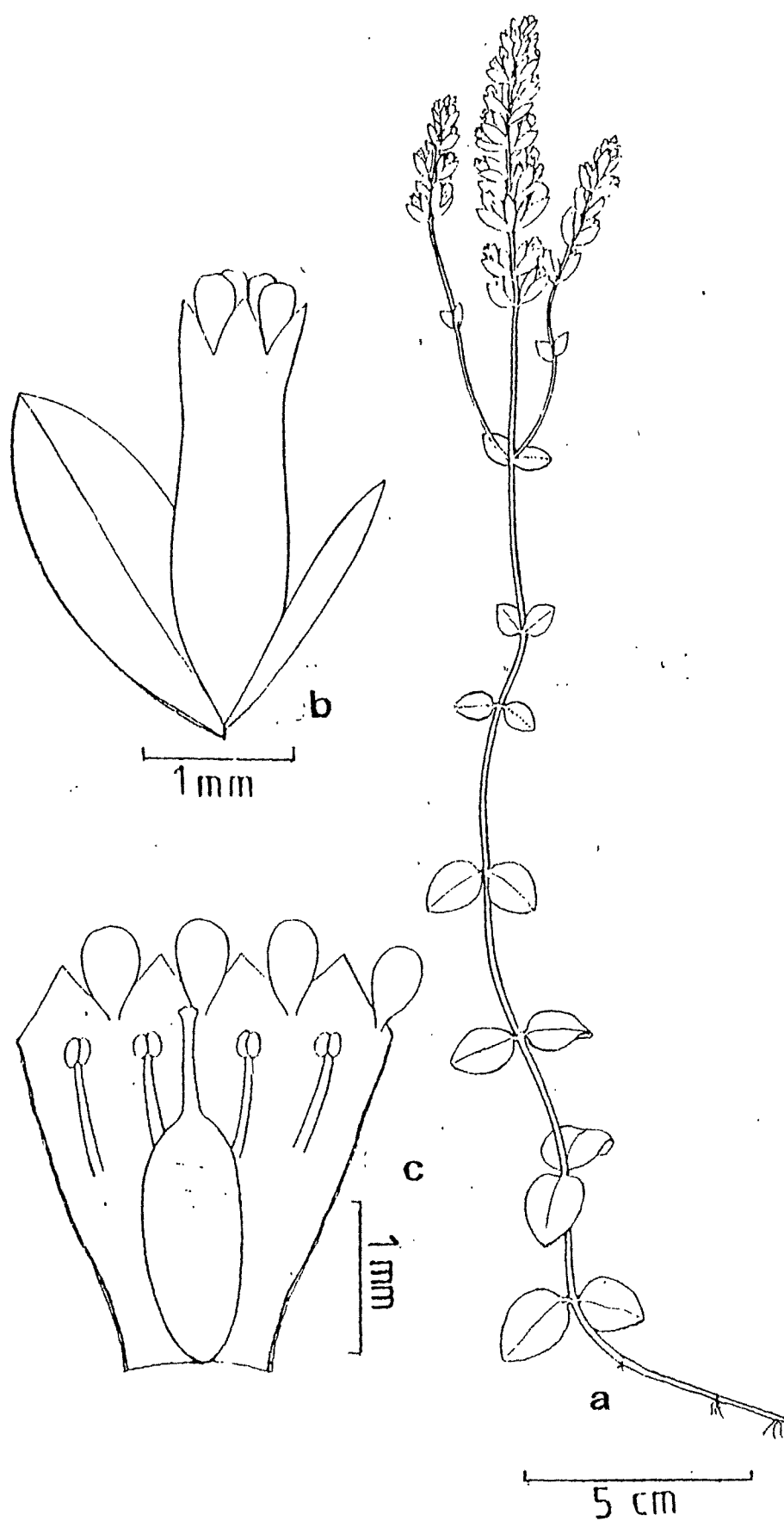
Fls. & Frts. October - March

Ecology: Growing gregariously on rocks in the streams and rivers and also in seasonally inundated areas.

Palynology:  $P = 17-22 \mu m$ ,  $E = 12 - 16 \mu m$ ,  $P/E$  ratio = 1.0 - 1.83; grains minutae and spheroid to prolate; pseudocolpi 0 or 3; pore  $\pm$  projected,  $\pm$  oval; amb triangular or angulo-circular, margin with 3 or 6 curves; sexine granular (Panigrahi, 1979).

Text Fig. 16. Rotala serpyllifolia (Roth). Brem.

- a. Habit
- b. Flower
- c. Flower dissection



Text Fig.16

Distribution: INDIA: Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Karnataka, Nager-Haveli, PAKISTAN; BENGLADESH. (Map 14).

Specimens examined:

BIHAR: Without precise locality, kurz s.n. (CAL).

KARNATAKA: Malabar, Concan, Hooker f. & Law s.n. (CAL).

GUJARAT: Saurashtra, Gir, 5.10.1953, Raizada 21384 (DD); Pimpri, Dangs forests, 16.10.1956, Asrana 3097 (BLAT); Waghai, Dangs, 23.12.1957, Asrana 5208 (BLAT); Baroda, Vasad, Mahiriver, 1.3.1958 Sabnes s.n. (DD); Rajkot, Pradyamna Park, October 1958, Murthy s.n. (BLAT); Vadgamba, 8.4.1959, Puri 56919 (BSI); Ahwa, Dangs, 23.11.1959, Wadhwa 60802 (BSI); Sasangir, 25.12.1959, Ansari 61056 (BSI).

MADHYA PRADESH: Rewa, Majgowan, January 1874, Kurz s.n. (CAL); Khandwa, Peplode, 9.12.1888, Duthie 8295 a (DD); Khandwa, Sendwil, 17.12.1888, Duthie 8295 (CAL, DD); Chandara (Chhindwara), Mardongri, 26.1.1891, Duthie 10399 (DD); Nimar, Tapti, near sondri, 10.2.1891, Duthie 10397 (DD); Baster, Kutra Zamindari, 31.12.1942,

Mooney 2142 (DD); Rewa, Chachai falls, 600 m, 9.2.1959, Sebastine 7678 (CAL, MH); Saugor, Rahatgarh, Bina river, 450 m, 1.3.1960, Subramanyam 10119 & 10129 (CAL, MH); Mandla, Bank of river Narmada, 6.2.1961, Joseph 12207 (MH); Indore, Naharjabaa, 18.12.1961, Rao 79206 (BSI); Bilaspur, Kathgora, 18.12.1964, Arora 7101 (CAL); Bilaspur, Lamni, February 1972, Murti 15390 (CAL).

MAHARASHTRA: Purandhar, December 1945, Kulp 8415 (BLAT); Pune, vithalwadi, 9.3.1956, Mahajan s.n. (BSI); Pune Givashi, 14.2.1958, Mahajan 32024 (BSI, CAL); Purandhar, 29.10.1961, Rao 32681 (CAL); Pune, Khed taluka, Shinga hills, 27.11.1961, Janardhanan 75911 (BSI); Pune, Ambavane, Petsahpur, 23.12.1963, Reddi 93365 (BSI, CAL); Dhule, Zapi to Dhadgaon, 14.3.1965, Pataskar 105167 (BSI, CAL); Thana, Viligaen range, Utawada hill, 20.10.1967, Billore 112974 (BSI, CAL); Thana, Harish chandragad foot hill, 19.11.1968, Billore 115802 (BSI, CAL); Nasik, Velunja, 4.2.1983, Narasimhan 165349 (BSI); Nasik, Peint beat, 6.2.1983, Narasimhan 165370 (BSI).

RAJASTAN: Chittorgarh, Orai dam site, 13.12.1963, Verma 1675 (CAL); Jhalawar, Kalisend river, 24.4.1964, Verma 3382

(CAL); Banswara, Bakani, 27.12.1964, Verma 7047 (CAL); Chittorgarh, Ekpera to Ghalawar, 26.12.1965, Mazumdar 10023 (CAL); Banswara, 18.10.1976, Singh 3720 (CAL).

UTTAR PRADESH: Agra, King 19 (CAL); Lalitpur, Barka, 7.1.1888, Duthie 6954 (DD); Jhansi, Baria Sagar, 9.12.1886, Duthie 6383 (DD); Chitrakoot, 13.11.1957, Rao 3726 (BSD); Mirzapur, Tanda falls, 9.2.1961, Bhattacharya 13607 (BSD).

DADRA & NAGAR HAVELI: Dudhani, 10.5.1963, Rolla 89162 (BSI); Damanganga river bank, 11.5.1965, Rolla 89205 (BSI); UMBERKOI, Dongerpada forests, 6.11.1970; Ansari 121957 (BSI); Velugaon, 15.11.1970, Ansari 127097 (BSI).

**17. *Rotala simpliciuscula* (S. Kurz) Koehne, in Engl., Bot. Jahrb. 1: 159. 1880 & in Pflanzenr. 17(4,216): 33. 1903; Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 711. 1918; Cook, Boissiera 29: 100. 1979.**

Ammannia simpliciuscula S. Kurz, J. Asiatic Soc. Bengal 40 (2): 54. 1871; Clarke in Hook. f., Fl. Brit. India 2: 568. 1879.

Amphibious annual herbs. Stems creeping and branching below, erect and simple above; erect branches 1-4 cm long, 4-angled. Leaves decussate, shortly petiolate, obovate or oblong, attenuate at base, obtuse or retuse at apex. Flowers solitary, pedicellate in axils of bracts; pedicel 0.5-1 mm long. Bracts leaf like, oblong to oblanceolate; bracteoles absent. Calyx tube campanulate, 0.25-0.35 mm long, lobes 3, 0.25-0.35 mm long, triangular; appendages 3, minute. Petals absent. Stamens 1 or occasionally 2, inserted below the middle of calyx tube. Ovary 0.5-0.75 mm long, globose; style very short; stigma capitate. Capsules c. 1.4 mm across, globose, exceeding the calyx tube, 3-valved. Seeds c. 0.5 mm long, sub-spherical.

Type: Bangladesh, Chittagong, Kurz s.n. (Holo. CAL\*).

Fls. & Frts. : September-November.

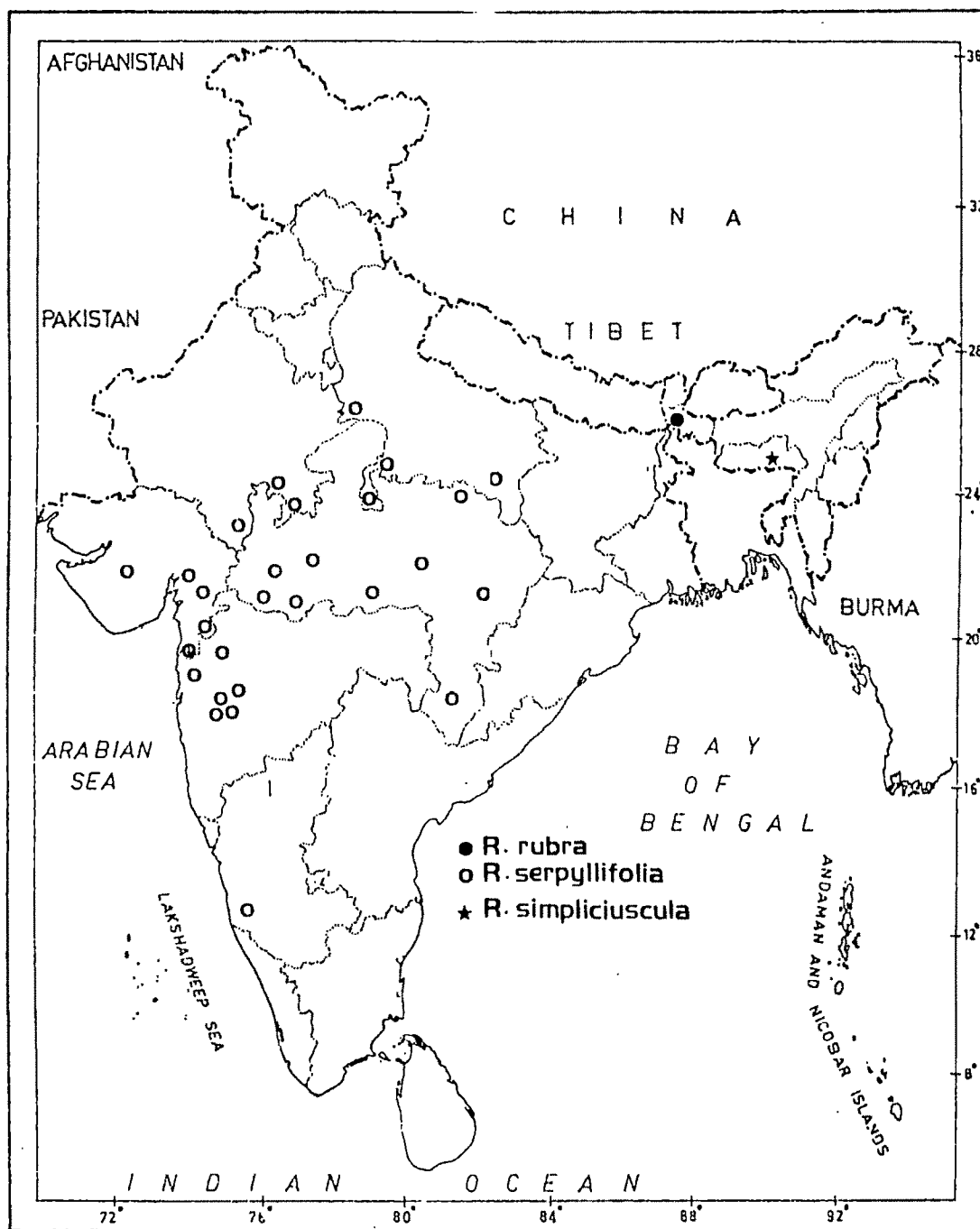
Distribution : INDIA: Meghalaya; BANGLADESH (Map 14).

Specimen examined:

INDIA: MEGHALAYA: Khasia, without collector (CAL).

BANGLADESH: Chittagong, Kurz s.n. (CAL); Chittagong, Hooker f. & Thomson s.n. (CAL).





Map 14. Distribution of *Rotala rubra*, *R. serpyllifolia* and *R. simpliciuscula* in India.

18. *Rotala subrotunda* (Wallich ex Kurz) Koehne in Engl., Bot. Jahrb. 1: 174. 1880. p.p. excl. var. polystachya (Wallich ex Wight & Arn.) Koehne; Cook, Boissiera 29: 115. 1979.

Ammannia subrotunda Wallich ex Kurz, J. Asiatic Soc. Bengal 40(1): 55. 1871, Flora (Regensb.) 54(19): 191. 1871 et in J. Asiatic Soc. Bengal 46(2): 85. 1871; Clarke in Hook. f., Fl. Brit. India 2: 571. 1879.

Ammannia latifolia Wallich in Wall. Cat. No. 2096, 1820 nom. nud. non L. 1753.

Rotala indica (Willd.) Koehne forma subrotunda (Wallich ex Kurz) Blatt. & Hallb., J. Bombay Nat. Hist. Soc. 25: 713. 1918.

Annual herbs. Stems creeping and rooting with numerous erect branches; branches upto 10 cm long, 4-angled. Leaves decussate, sessile, 4-8 (12) x 3-8 mm, ovate to orbicular rarely elliptic, obtuse to cordate at base, obtuse at apex. Flowers solitary, pedicellate in axils of bracts on short secondary or tertiary branches. Bracts leaf like, c. 1.5 x 0.5 mm, elliptic. Bracteoles 2, c. 0.7 mm long, shorter than

calyx tube. Calyx tube campanulate, c. 1.25 mm long, lobes 4, c. 0.6 mm long, sharply triangular, acute at apex, margin calcarious. Petals 4, c. 0.8-1 x 0.4 mm, obovate, tapering towards base, emarginate at apex, margin fringed, longer than calyx tubes. Stamens 4; filaments attached below the middle of calyx tube, 1.5-2 mm long; anthers well exserted. Ovary c. 0.5 mm long, ellipsoid; style c. 1.5-2 mm long; stigma capitate, exserted, level with anthers. Capsules c. 1 mm long, ellipsoid, 2-valved. Seeds c. 0.4 mm long, ellipsoidal (Fig. 17).

Type: Burma, Sagaen (Sagaing) 1826, Wallich 2096 (Holo. - CAL\*; iso. K-W, Photo CAL\*).

Fls. & Frts. : December-April.

Distribution: INDIA: Manipur; BURMA (Map 14).

Notes: Blatter & Hallberg (1918) reduced Rotala subrotunda into a forma of R. indica and mentioned that R. indica is a variable species. Cook C.D.K. (1979) gave specific status to R. subrotunda and mentioned the following diagnostic fetures. "Like R. indica plants usually taller and more branched; flowers distinctly pedicellate, not borne on main axis; petals relatively large and showy, upto 1 mm

Fig. 17. Type photograph of Rotala subrotunda (Wallich ex Kurz) Koehne.



1254

*Ammannia latifolia*  
Lagun. Wall. 10792  
P. 1 2076

FLORA BRIT. INDIA. II 566  
Dr. C. B. CLARKE

*Portula subrotunda* (Kurz) Koeber  
*Ammannia latifolia* Wall. non L.  
nec Walp. nom. und.

Det./Rev. C. D. K. Cook, 1976.

Upper Burma



2096 *Ammannia latifolia* Mill  
*A. latifolia* L.  
Lagun 1826



B51 N14  
5834



155274  
157  
K.W.

Obbama  
2076 February 68  
Dr. H. N. B. G.  
YUNAN EXPEDITION, Feb 1977  
*Ammannia latifolia*

17

long; anthers and stigmas exserted and borne above the petals". After examining the holotype, which was not seen by Cook, and other available materials from India and Burma, the present author also supports the concept of species held by Koehne (1880) and Cook C.D.K. (1979).

(2) The holotype which was hitherto unknown is located from CAL.

Specimens examined:

INDIA: MANIPUR: Laireen, c. 1000 m, April 1882, Watt 7312 (CAL); Palel, 750 m, 16.12.1942, Bore, 17217 (DD).

BURMA: Sagaen, 1826, Wallich 2096 (CAL); Mandalay, 9.1.1868, Anderson s.n. (CAL); Katha, 19.1.1968, Anderson (CAL); Myitkyina, February 1900, Mokim 40 (CAL); Monywa, December, 1907, Meebold 7928 (CAL); Myitkyina, February, 1909, Buchanan 76 (CAL).

19. *Rotala verticillaris* L., Mant. Pl. 2: 175. 1771; DC., Prod. 3: 76. 1828; Wallich, Num. List No. 6321. 1829 nom. nud.; Wight & Arn., Prod., Fl. penin. Ind. Or. 1: 303. 1834; Wight, Ic. Pl. Ind. Or. 1: t. 260 A. 1840;

Miq., Fl. Ind. Bat. 1: 614. 1855; Blume, Mus. Lugd. Bat. 2: 136. 1856; Thwaites, Enum. Pl. Zeyl. 122. 1864; Koehne in Engl., Bot. Jahrb. 1: 153. 1880 & in Pflanzennr. 17 (4, 216): 30. 1903; Blatt. & Hallb., J. Bombay Nat. Hist Soc. 25: 705. 1918; Gamble, Fl. Pres. Madras 508. 1919; Cook, Boissiera 29: 23. 1979; Joseph & Sivar, Proc. Indian Acad. Sci. (Plant Sci.) 99(3): 196. 1989.

Ammannia rotala Clarke in Hook. f., Fl. Brit. India 2: 567. 1879; Trim., Fl. Ceylon 2: 224. 1894 non F. V. Muller, 1862.

Rotala petaloidea Wight ex Steudel, Nom. Bot. ed. 2, 2: 474. 1841 nom. nud.

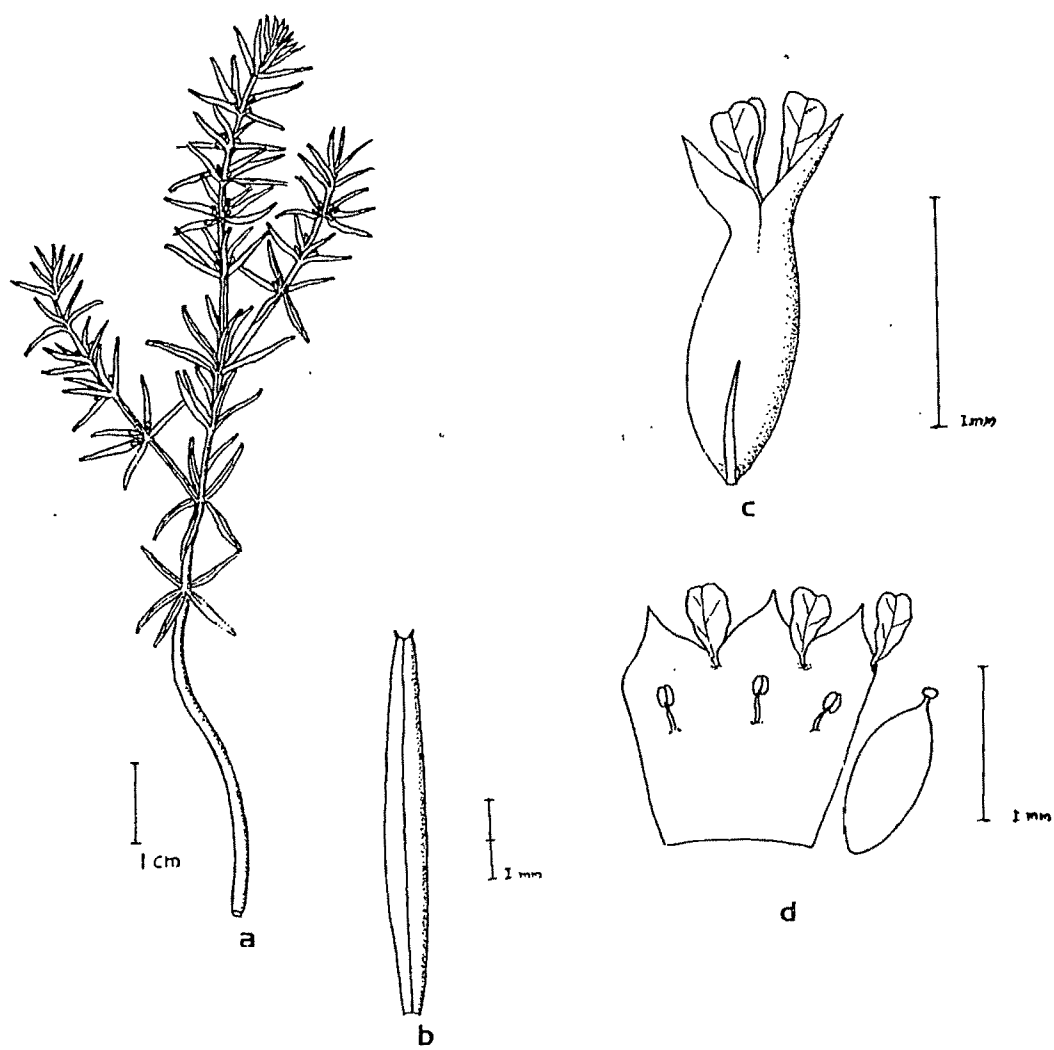
Type: India orientalis, Linn. Herb. 52/1 (LINN, microfische - CAL\*).

Amphibious annual herbs. Stems 4-18 cm long, simple or branched, creeping and rooting below, erect above, terete below, angular above. Leaves in whorls of 4-10 or rarely decussate below, 3-10 x 0.5-1 mm, sessile, linear, cuneate at base, truncate or bifid at apex. Flowers monomorphic, solitary, sessile, trimerous, in axils of leaf-like bracts.

Text Fig. 17. Rotala verticillaris L.

- a. Habit
- b. Leaf
- c. Flower
- d. Flower dissection





Text Fig. 17

Bracteoles 2, less than 1 mm long. Calyx tube 1.5-3 mm long, membranous, suburceolate, constricted below the mouth, lobes 3, c. 0.5 mm long, deltate, appendages absent. Petals 3, c. 0.5 mm long, obovate, pink. Stamens 3, inserted above the middle of calyx tube; anthers included. Ovary c. 1.5 mm long, ellipsoid; style minute; stigma capitate. Capsule c. 2 x 1 mm, ellipsoid, 3-valved. Seeds 0.35-0.45 mm long, ovoid, black (Text Fig. 17).

Fls. & Frts. : August - March.

Ecology: Erect herbs growing on damp places usually in coastal areas.

Distribution: INDIA: West Bengal, Orissa, Andhra Pradesh, Tamil Nadu; SRI LANKA (Map 15).

Palynology: P = 18-21  $\mu$ m, E = 10-14  $\mu$ m, P/E ratio = 1.3-2.1; grains minutae and prolate; pseudocolpi absent or 3 in number; pores  $\pm$  circular and projected; amb triangular; sexine-smooth. (Panigrahi, 1979).

Notes: (1) R. verticillaris L. is reported here for the first time from West Bengal.

(2) Cook (1979) has recorded that the most recent collection from South India he has seen was 1915, and he commented that "it is probable that it has become very rare or even extinct. However, the author could find collections which were recently collected.

Specimens examined:

ANDHRA PRADESH: Nellore, Tada, 13.3.1901, Bourne 2144 (CAL); Chittoor, Chandragiri, 23.3.1914, Without collector 10006 (MH); Chittoor, Chawala Valley, 308 m, 23.3.1918, Fishcer 4298 (CAL).

ORISSA: Bolakhad, 21.3.1965, Abraham 167 (CAL); Konark, 7.12.1965, Banerjee 5981 (CAL).

TAMIL NADU: Madras, 1.2.1899, Barber 134 (MH); Madras, Nungambakam, 10.12.1899, without collector (MH); Chengalput, Vandalur, 7.2.1915, Barber 11512 (MH); Vandalur, 12.1.1957, Balakrishnan 262 (MH); Madurai, Perumalkoil tank, 13.1.1957, Subramanyam 3508 (CAL, MH); Tirunelveli, Singampatti, 92 m, 3.3.1958, Sebastine 5502 (CAL, MH); Thiruchirappalli, Poovarasankudi, 75 m, 22.9.1968, Ramamurthy 25912 (MH); Chengalput, Karikili water Fowl Refuge, 120 m, 27.1.1976, Henry 47092 (CAL, MH); Pudukkottai, Siddannavasal, 100 m, 2.2.1978, Ramamurthy 53744 (MH).

WEST BENGAL: Birbhum, Bhairabdihi, Charicha, 23.12.1969,  
Basak 1330 (CAL).

20. *Rotala wallichii* (Hooker f.) Koehne, Bot. Jahrb. 1: 154.  
 1880 & in Pflanzennr. 17 (4, 216): 31. 1903; Blatt. &  
 Hallb., J. Bombay Nat. Hist. Soc. 25: 706. 1918; Cook,  
 Boissiera 29: 1979.

Hydrolythrum wallichii Hooker f. in Benth. & Hook. f.,  
 Gen. Pl. 1: 777. 1867 & Hook. f., Ic. Pl. 2: 5. t.  
 1007. 1867; Clarke in Hook. f., Fl. Brit. India 2:  
 575. 1879; Prain, Bengal Pls. 1: 501. 1903

Ammannia wallichii (Hooker) S. Kurz, J. As. Soc. Bengal 46:  
 2. 1877.

Type: Burma, Tavoy 1827, Gomez in Wall. Cat. No. 9059.  
 (Holo.-K-W, Photo. CAL\*).

Glabrous aquatic herbs. Stems upto 20 cm long, branched  
 below, simple above, floating or erect, with number of  
 longitudinal ridges and furrows. Leaves in whorls of upto 12  
 or more, dimorphic; submerged leaves linear, c. 2 cm long, 1  
 mm wide, bifid at apex; aerial leaves lanceolate or oblong,

2.5-4 mm long, obtuse or retuse at apex, less in number. Bracts in whorls of upto 6, oblong-ovate, 2-3.5 x 1-2 mm, acute or bifid at apex. Flowers monomorphic, subsessile in axils of bracts; bracteoles c. 0.5 mm long, linear. Calyx tube campanulate, c. 1.5 mm long; lobes 4, c. 0.5 mm long triangular. Petals 4, c. 2.5 mm long, obovate. Stamens 4, inserted below the middle of calyx tube; filaments c. 1 mm long; anthers level with the top of calyx lobes; nectar scales 4, bifid. Ovary c. 1 mm long, globose, 2-loculed; style c. 0.5 mm long; stigma capitate. Capsule c. 1 mm across, 2 valved. (Text Fig. 18).

Fls. & Frts. : August-March.

Distribution: INDIA: West Bengal; BURMA; THAILAND; MALAYA; CHINA; THAIWAN. (Map 15)

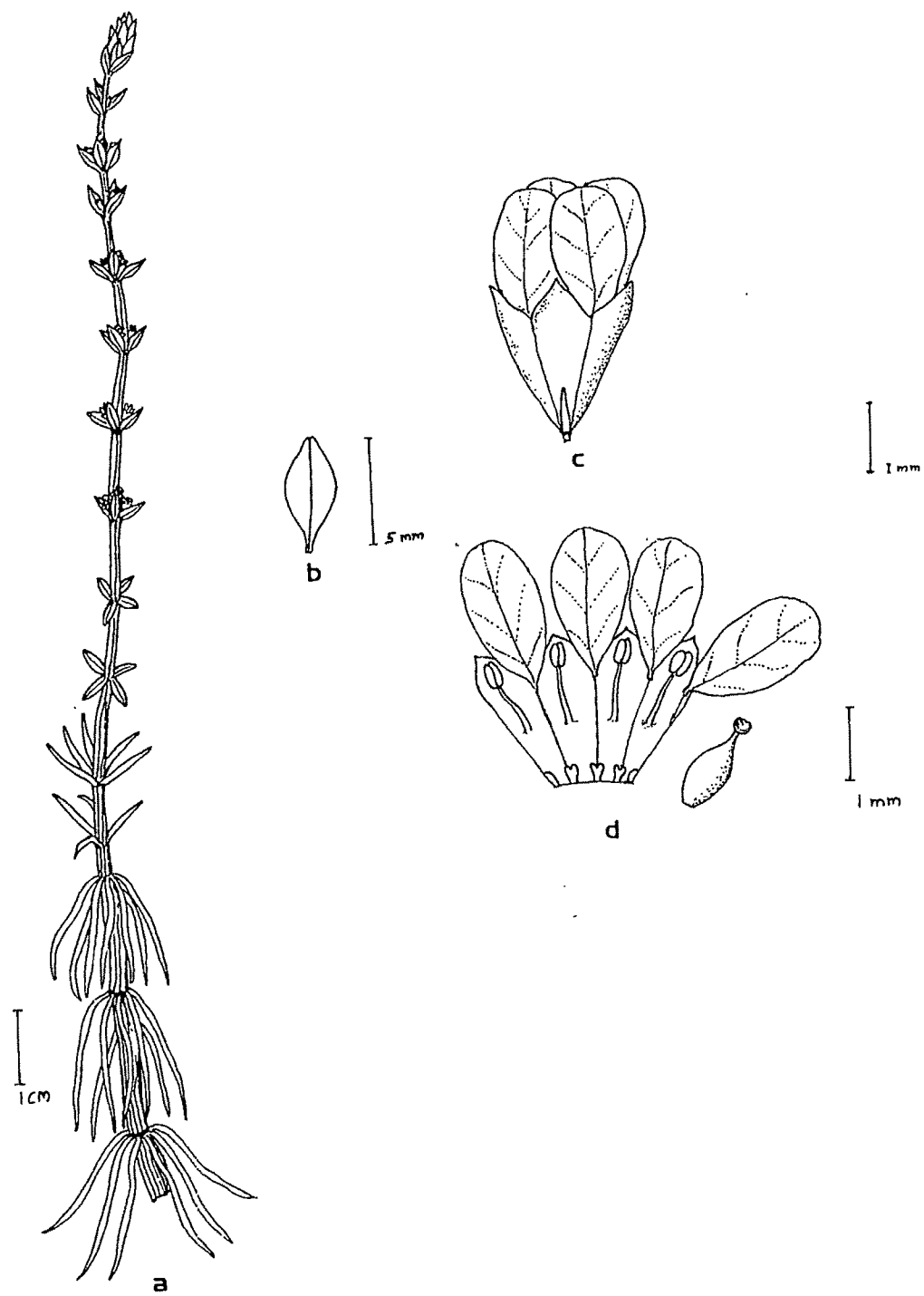
Notes: R. wallichii is represented in India by a single gathering of Haines in Oct. 1895 from Duars, West Bengal. Vasudevan Nair's (1965) report from Kerala, South India as Hydrolythrum wallichii is actually R. cookii Joseph & Sivar.

Specimens examined:

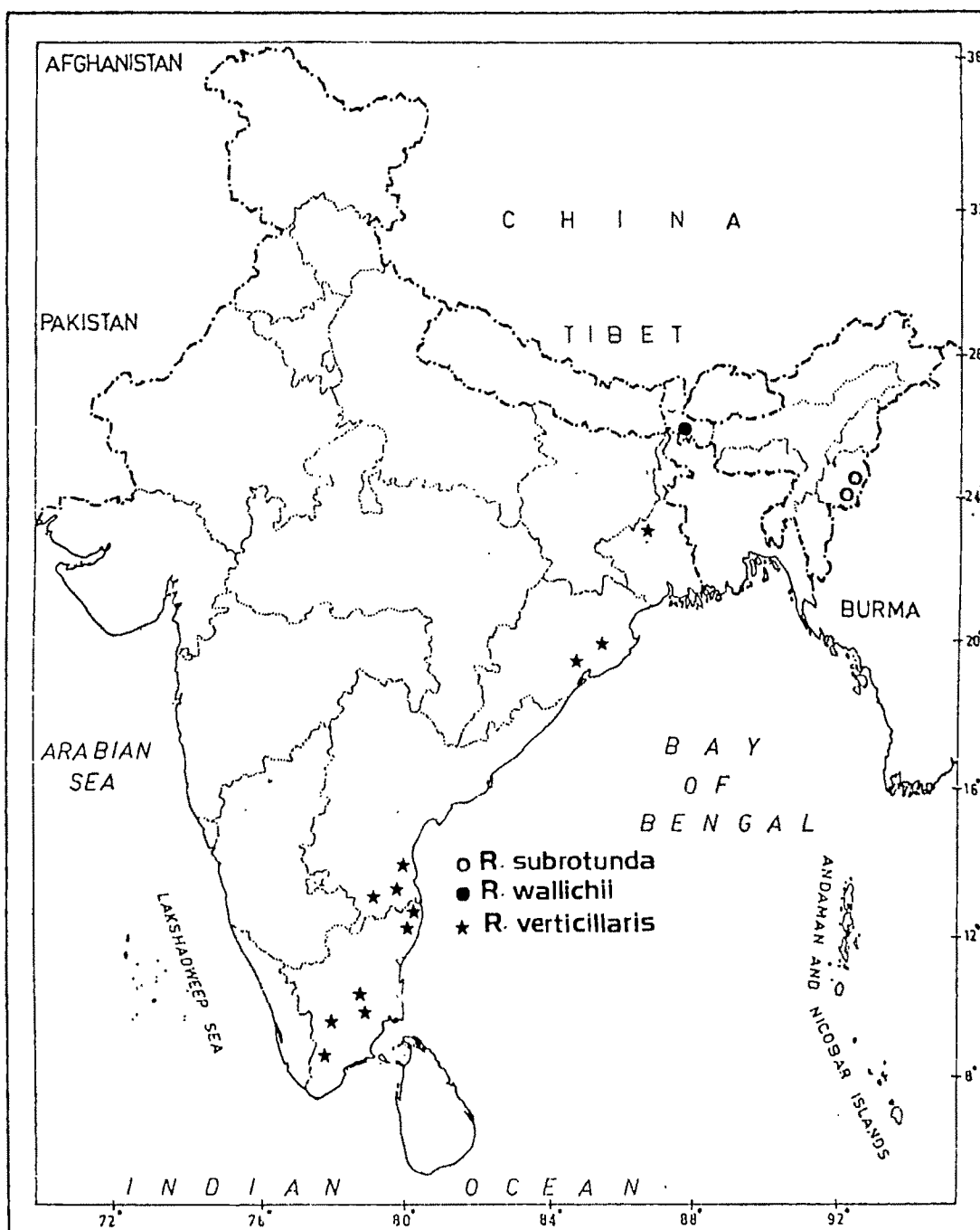
WEST BENGAL: Jalpaiguri, West Duars, October 1895, Haines 560 (CAL).

Text Fig. 18. Rotala wallichii (Hooker f.) Koehne

- a. Habit
- b. Bract
- c. Flower
- d. Flower dissection



Text Fig. 18



Map 15. Distribution of *Rotala subrotunda*, *R. wallichii* and *R. verticillaris* in India.



## 8. WOODFORDIA

**Woodfordia** Salisb., Parad. Lond. t. 42. 1806; Hook. f. in Benth. & Hook. f., Gen. Pl. 1: 778. 1867; Baill., Hist. Pl. 6: 430. 1877; Clarke in Hook. f., Fl. Brit. India 2: 572. 1879; Koehne in Engl., Bot. Jahrb. 1: 333. 1881 & in Engl., Pflanzenr. 17(4) 216: 78. 1903; Brandis, Ind. Trees 341. 1911; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan 78: 5. 1975.

Lythrum L., Sp. Pl. ed. 2: 641. 1795 p.p.

Grislea Roxb., Pl. Coromandel 1: 29 t. 31. 1795; DC., Prodr. 3: 92. 1828.

Type: Woodfordia fruticosa (L.) Kurz, J. As. Soc. Bengal 40 (2): 56. 1871.

Shrubs or often arborescent, perennials; stems woody highly branched; branches glabrescent. Leaves decussate, thick, coriaceous, black glanduler-dotted beneath, tomentose. Inflorescences axillary, compact cymes, much branched, few-flowered. Flowers weakly zygomorphic, 6-merous, pedicellate, bibracteolate, red. Calyx cyathiform to tubular, curved, glanduler-dotted; calyx lobes 6, erect, short; appendages 6, minute. Petals 6, small, narrowly lanceolate-linear, acuminate, red. Stamens 12, inserted

below the middle of calyx tube, exserted, unequal, episepalous longer. Ovary sessile or subsessile, fusiform; style long, exserted; stigma punctiform-barely capitate. Capsules ellipsoid, included with in the calyx tube, indehiscent or splitting variously. Seeds many, oblong-truncate or linear ovate.

#### Ecology and distribution

The genus Woodfordia comprises two species of semixerix habitats, W. uniflora from Africa and W. fruticosa which ranges from East Africa to Southern Asia. Fossil records of Woodfordia have been reported from the pleistocene flora of Kashmir (Puri, 1943).

#### Chromosome numbers

$2n = 16$  and  $n = 8$  have been reported for this genus (Sharma, 1970; Mehra, 1976; Graham, 1992).

#### Palynology

Pollen prolate, amb circular; tricolporate, colpi meridionally elongated, equatorially arranged, equidistant, straight, c. 12-14  $\mu\text{m}$  long, extending within c. 4  $\mu\text{m}$  of pole

(PI 0.28), P/E 1.3, margin entire, tapering to acute apex, costae colpi c. 1-1.5  $\mu$ m wide, colpus membrane psilate to faintly and minutely granular, ectexine bridge over pore, pore circular, diameter 2  $\mu$ m, situated at midpoint of colpus margin entire; wall 1-1.5  $\mu$ m thick, scabrate; tectate; 16-22 P x 12-16 E  $\mu$ m (Graham et al., 1990).

**Woodfordia fruticosa** (L.) Kurz, J. As. Soc. Bengal 40(2): 56. 1871 & Forest Fl. Brit. Burma 1: 517. 1877; Koehne in Engl., Bot. Jahrb. 1: 333. 1881 & in Engl., Pflanzennr. 17(4, 216): 79. 1903; Gamble, Fl. Pres. Madras 1: 511. 1919; Haines, Bot. Bihar & Orissa 3: 374. 1922; Kanjilal & Das, Fl. Assam 2: 213. 1938; Hara, Fl. East. Him. 218. 1966; Iqbal Dar in Nasir & Ali, Fl. W. Pakistan 78: 6. 1975; Hara in Hara & Williams, Enum. Flow. Pls. Nepal 2: 173. 1979.

Lythrum fruticosum L., Syst. ed. 10. 1045. 1759.

Grislea tomentosa Roxb., Pl. Coromandel 1: 29. t. 31. 1795.

Woodfordia floribunda Salisb., Parad. Lond. t. 42. 1806; Clarke in Hook. f., Fl. Brit. India 2: 572. 1879; Trim., Fl. Ceylon 2: 226. 1874; Duthie, Fl. Upp. Gang. Plain 1: 351. 1903; Prain, Bengal Pls. 1: 502. 1903; Cooke, Fl. Pres. Bombay 1: 543. 1903.

626.4

Type: Herb. Linnaeus 62<sup>6</sup>/<sub>1</sub>4 (LINN; Microfiſche CAL\*)

Local names: Dhawi-phul (Beng., Hind.); Tamarapushpi (Kan.); Phulsatti, Dhauri, Dhayati, (Mar.); Jatigo, Harwari (Or.); Pagadam, Jargi, Seringi (Tel.); Dhatripushpika, Dhataki, Agnivala (Sans.).

Shrubs, 1-4 m tall, much branched, young parts more or less greyish pubescent, gland dotted. Leaves subsessile, 2-10 x 0.8-3 cm, linear-lanceolate or ovate-lanceolate, cordate at base, acuminate at apex, entire, greenish above, black gland dotted below, white pubescent. Flowers in fascicled axillary cymes, 3-16 flowered, brick red. Calyx tube 6-13 mm long, 2-5 mm broad, cylindrical, curved, constricted at base, lobes 6, c. 3 mm long, erect, deltoid; appendages 6, 0.2-0.3 mm long. Petals 6, 3-4.5 x 0.5-0.75 mm, narrowly lanceolate-linear, acuminate, red. Stamens 12, filaments filiform, inserted at the bottom of calyx tube, unequal, episepalous longer, all exserted. Ovary fusiform, sessile or subsessile, 2-locular; style 13-14 mm long; stigma punctiform-barely capitate. Capsules 5-10 x 2.5-5 mm, ellipsoid, enclosed by persistent calyx tube, indehiscent or splits irregularly. Seeds numerous, 0.6-0.8 x 0.4-0.5 mm, oblong-truncate or linear-ovate (Fig. 18).

Fls. & Frts.: January - May

Fig. 18. Habit of Woodfordia fruticosa (L.) Kurz.



Distribution: INDIA: Jammu & Kashmir, Himachal Pradesh, Punjab, Rajasthan, Uttar Pradesh, Bihar, West Bengal, Assam, Mizoram, Manipur, Meghalaya, Sikkim, Orissa, Madhya Pradesh, Gujarat (Santapau, 1962), Maharashtra, Andhra Pradesh, Goa, Karnataka; PAKISTAN; CHINA TO SUMATRA; JAVA; MADAGASCAR (Map 16).

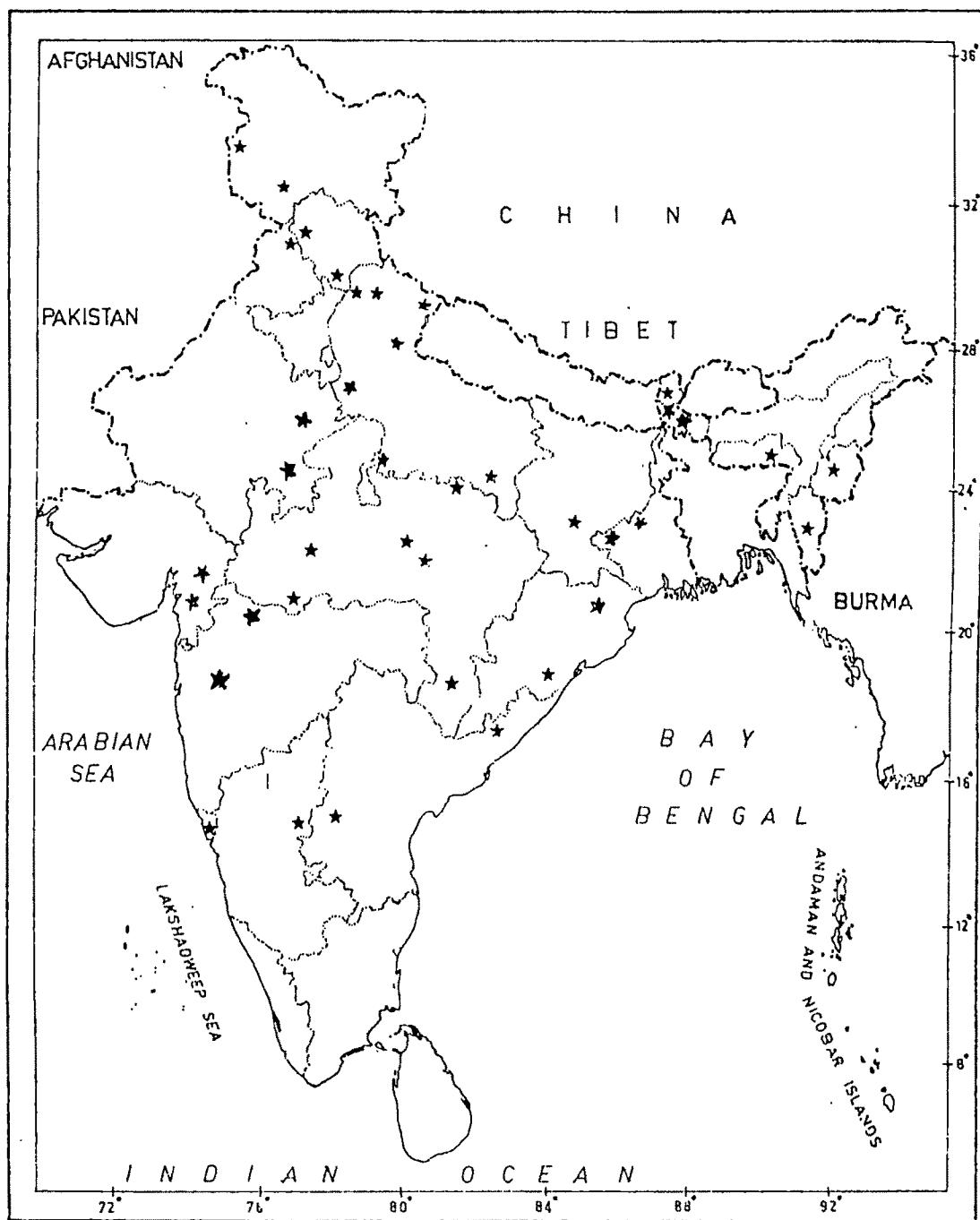
Uses: Leaves and twigs yield an yellow dye which are useful for printing. The flowers are a source of hair dye and the dried flowers and leaves are used medicinally as an astringent and a remedy for dysentary (Shome et al., 1981).

Notes: Anatomically, the genus is stand alone in Indian Lythraceae by its possession of true tracheids (Baas, 1986).

Specimens examined:

ANDHRA PRADESH: Kurnool, Mantalakanama, 600m, February 1887, Gamble 18723 (MH); Vizhak, Krishnadevipeta, 4.3.1915, Rangachary 11706 (MH); Kurnool, Nallamalais, Way to Ramanpenta, 710 m, 31.3.1965, Ellis 23024 (MH); Vishakapatnam, way to Agraharam from Gudem, 875 m, 29.10.1972, Subbarao 42797 (MH).

ASSAM: Doymer plain, water spring, march 1853, Prain s.n. (CAL).



Map 16. Distribution of *Woodfordia fruticosa* in India.



BIHAR: Ranchi, Koilkam River basin, 20.2.1981, Malick & Party 9729 (CAL).

GOA: South Goa, Chafolin, on way to Canacona, 3.3.1985, Naithani 1196 (DD).

HIMACHAL PRADESH: Bashahr, Nirt, 24.4.1891, Lace 846 (CAL); Buneira to Bakloh, 600-1200 m, 19.3.1899, Lace 1897 (CAL); Kangra, Kotla, Barrom Hills, 8.5.1902, Watt 15233 (CAL); Kangra, 750 m, 16.3.1902, Herb. R.E.P 15501 (CAL); Kalka, 31.3.1961, Rau 14547 (BSD); Jeori, 1400 m, 24.5.1962, Nair 21800 (BSD); Rampur, 17.6.1962, Nair 20842 (BSD); Sahu, Kali Village, 14.6.1974, Wadhwa 52912 (BSD, CAL).

JAMMU & KASHMIR: Muzaffarbad, Kishanganga valley, 1050 m, Keshavanand 1661 (DD); Udhampur, Ramnagar, 23.3.1986, Ajayswami 539 (BSD); Rehalta - Thein Dan, on the hill slopes, 14.8.1986, Hajra 82566 (BSD).

KARNATAKA: Bellary, Ramandurg, 7.10.1919, without collector 15905 (MH).

MADHYA PRADESH: Khandwa, 27.12.1888, Laurie 8297 (DD); Banda, Kurdawai Jungle, 3.3.1901, Bell 46 (CAL); Banda, Jungle, 18.5.1901, Bell 431 (CAL); Rewa, Bughelkhand area, Govindgarh, 650 m, 8.2.1959, Sebastine 7630 (MH);

Saugor, Rahatgarh, 450 m, 1.3.1960, Subramanyam 10108 (MH); Baster, Kaskal, 700 m, 6.2.1961, Balakrishnan & Henry 11852 (CAL, MH); Mandla, Kheri R.F., 675 m, 29.11.1961, Joseph 13490 (MH); Jubbulpore, Kundwara, 472 m, 8.3.1962, Sebastine 13856 (MH).

MAHARASHTRA: Khandala, 5.6.1950, Braganza 285 (DD); Khandala, near Shingaroba temple, 21.3.1956, Jain 4 (CAL); Khandesh, Gangapuri, 4.3.1957, Mahajan 13101 (CAL); Katraj, 6.3.1957, Puri 12201 (CAL).

MANIPUR: Boishing, 1200 m, 25.4.1882, Watt 6735 (MH).

MEGHALAYA: Khasia, 1879, Fisher s.n. (CAL)

MIZORAM: Lushai hills, Parry s.n. (CAL); without precise locality, clayey soil in rocks, 20.1.1963, Deb 31063 (CAL).

ORISSA: Ganjam, Boroborosinghi, 300 m, March 1884, Gamble 14085 (MH); Ganjam, Udayagiri, 19.1.1900, Barber 1121 (MH); Ganjam, Simonbadito, Darangambadi, 2.2.1900, Barber 1349 (MH); Mayurbhunj, Barhepani, 780 m, 4.5.1941, Razi 38 (CAL); Nursingpur, Angul, 60 m, 19.3.1943, Biswas 6150 (CAL).

PUNJAB: Hoshiarpur, Jaijon, 8.7.1971, Misra 44374 (BSD);  
Hoshiarpur, Dholbah, 1.8.1971, Misra 38273.

SIKKIM: Teesta, 4.3.1871, Clarke 13950 A (CAL); Sikkim  
Himalaya, Without locality, 1875-76, King s.n. (CAL);  
Sikkim Himalaya, Duars, 1893, Haines 365 (MH).

UTTAR PRADESH: Nainital, Ramnagar, Chilikia range, 480 m,  
15.4.1913, Singh 60 (DD); Garhwal, Jha, 1065 m,  
25.4.1913, Singh 5865 (DD); Dehra Dun, Nalapani,  
8.3.1957, Rao 1872 (BSD); Dehra Dun, Mathronwala,  
700 m, 13.5.1958, Dakshini 3986 (BSD); Jhansi, Dudhi  
R.F., 13.3.1959, Rao 8418 (BSD); Garhwal, Lansdowne,  
23.2.1960, Vohra 9975 (BSD); Mirzapur, T. Falls,  
8.2.1961, Bhattacharyya 21036 (BSD); Tehri, Chamon,  
800 m, 5.3.1979, Goel 65896 (BSD); Pithoragarh, Garja,  
14.4.1984, Balodi 75506 (BSD).

WEST BENGAL: Darjeeling, Sivoke, December 1899, Prain's  
Collector s.n. (CAL); Birbhum, Nalhati, 27.3.1966,  
Basak 158 (CAL); Jalpaiguri, Titi, 3.3.1976, Sikdar  
4488 (CAL); Purulia, Matha R.F., 10.5.1988, Mathew  
13115 (CAL).

**TAXONOMIC STUDIES ON THE FAMILY LYTHRACEAE IN INDIA**

**CHAPTER II**

**SEED MORPHOLOGICAL STUDIES USING SEM**

## A. INTRODUCTION

During the last decade the application of Scanning Electron Microscope(SEM) has greatly increased our knowledge of plant surfaces. The SEM is a surface microscope and the subject under examination is the natural primary surface of a plant - the epiderm, which covers roots, stems, leaves, flowers, fruits and seeds. The epidermal characters are very little affected by the enviornmental conditions and there is evidence for a strong genetic control over it (Cutlor and Brandham 1977, Cutler 1979, Barthlott 1981). As Such, epiderm, the primary natural surface of all plant organs present an array of structural diversities and provides valuable information for application to systematics and evolution (Barthlott, 1981). In recent years considerable information have been obtained about the ultrastucture of spermoderms (testa) through the use of SEM.

The SEM study of spermoderms of seeds are carried out for the Indian representatives of the family Lythraceae to facilitate the taxonomic understanding as the differences in spermoderm characters are known to have relationships with the specific variability of certain taxa.

Studies of the seeds of Lythraceae have been few and limited. Corner (1976) studied the morphological and

anatomical aspects of some of the seeds of the family. Panigrahi (1986) studied the seed-surface characteristics of a few species of the genera Rotala L., Ammannia L., Nesaea Kunth and Hionanthera Fernandes & Diniz using the SEM. Seed characters have been little used in the systematics of the group, and a comprehensive study of surface morphology has never been made for the representative of Indian Lythraceae.

In the present study, the author examined and described the seeds of 31 of the 42 indigenous species of Lythraceae. Representatives of all the 8 genera have been studied. Within each genus attention has been given to various species complexes (which raised confusions) in their taxonomic status.

## B. MATERIALS AND METHODS

Seeds for this study were taken from mature capsules of authentic herbarium specimens deposited in the Central National Herbarium, Indian Botanic Garden, Howrah (CAL) and the Blatter Herbarium, Bombay (BLAT). Vouchers of species studied are listed in table 2.

The seeds were first observed under the light microscope and therefore mature, dry and cleaned seeds were

selected. Measurements were made with an ocular micrometer and light microscope. Dry seeds were mounted directly on SEM stubs by both side adhesive tape and coated with gold-palladium in vacuum coating apparatus. They were examined and photographed in a PSEM 500, Philips and Jeol-JSM-35C scanning electron microscope at 20 KV accelerating voltage. Surface pattern of seeds were examined, in different magnifications, with as many seeds of a species being mounted on one stub possible. For each species descriptions is given in detail based on available terminology.

### C. TERMINOLOGY

The primary and secondary structures of spermoderm of seeds are described in this work based on available terminology of Murley (1951), Barthlott (1981) and Shetler & Morin (1986). Where the form does not tally with a definite available term, english words are used rather to describe it.

Foveolate:	Pitted or perforated
Lineate:	Marked with fine lines
Lumen:	The interspace surrounded by the lines of a reticulum
Papillose:	Bearing small rounded projections or protuberances

- Radial wall: The superficially visible cell boundary
- Reticulate: With a raised network of narrow and sharply angled lines frequently presenting a geometric appearance, each area of depression outlined by the reticulum being an interspace.
- Rugose: Wrinkled, the irregular elevations making up the wrinkled nature and the interspaces enclosed by the elevations have shallow furrows.
- Striate: Marked with a series of fine narrow parallel bands
- Tangential wall: The superficial wall visible inside the cell boundary.

#### D. INTERPRETATION OF SPERMODERM SCULPTURING PATTERN

Ammannia auriculata Willd. (Figs. 19, 20)

Seeds 0.38-0.42 x 0.30-0.35 mm, more or less rectangular, spermoderm (testa) in lower magnification (Fig. 19 xl60) somewhat smooth; in higher magnification (Fig. 20 xl250) spermoderm cells conspicuous, elongate; radial walls relatively indistinct and channelled; outer tangential walls more or less convex and foveolate throughout the surface.



Ammannia baccifera L. (Figs. 21, 22)

Seeds 0.36-0.39 x 0.27-0.30 mm, triangular-ovoid. Spermoderm in lower magnification (Fig. 21 x320) reticulate, lumina of the reticulum irregular; in higher magnification (Fig. 22 x1250) spermoderm cells conspicuous, elongated; radial walls thickened and raised; outer tangential walls depressed to form lumen of relatively larger size.

Ammannia desertorum Blatter & Hallb. (Figs. 23, 24)

Seeds 0.42-0.48 x 0.3-0.33 mm, triangular-ovoid. Spermoderm in lower magnification (Fig. 23 x160) rugose-reticulate; in higher magnification (Fig. 24 x640) spermoderm cells conspicuous, irregular in shape with moderately thick and raised radial walls and relatively inconspicuous lumen. Ornamentations of raised walls somewhat obscure.

Ammannia multiflora Roxb. (Figs. 25, 26)

Seeds 0.30-0.45 x 0.26-0.38 mm, triangular-ovoid. Spermoderm in lower magnification (Fig. 25 x320) reticulate; in higher magnification (Fig. 26 x640) spermoderm cells conspicuous, elongate; radial walls uniformly and

conspicuously thick walled, raised, with scattered pores throughout its surface; the outer tangential walls collapsed, forming a narrower lumen due to the thickening of the radial walls.

Ammannia nagpurensis Mathew et Nayar (Figs. 27, 28).

Seeds 0.25-0.35 x 0.20-0.25 mm, ovoid. Spermoderm in lower magnification is reticulate (Fig. 27 x320); in higher magnification (Fig. 28 x1250) spermoderm cells conspicuously thick walled, quadrangular in outline and forming convex uniform papillae at the cell corners.

Ammannia octandra L. (Figs. 29, 30)

Seeds 0.50-0.57 x 0.33-0.42, ovoid. Spermoderm in lower magnification (Fig. 29 x160) is rugose; in higher magnification (Fig. 30 x640) spermoderm cells are irregular in shape; radial walls thick, raised, having obscure secondary ornamentation pattern; outer tangential walls intact, slightly depressed.

Ammannia senegalensis Lamk (Figs. 31, 32).

Seeds 0.35-0.38 x 0.27-0.30 mm, ovoid. Spermoderm in lower magnification (Fig. 31 x160) is reticulate; in higher

magnification (Fig. 32 x640) spermoderm cells are rectangular with thick and raised radial walls and sometimes unevenly depressed or with collapsed outer tangential walls.

Lagerstroemia indica L. (Figs. 33, 34)

Seeds 6.0-10 x 3.0-4.0 mm, unilaterally winged with a pyramidal seed body. Spermoderm shows thickly walled reticulate ornamentation in the lower magnification (Fig. 33 x260). In higher magnification (Fig. 34 x1000) spermoderm cells are polygonal or isodiametric with concave outer tangential walls. The anticlinal boundary and cell junctions are channelled, and in between some of the cells irregularly shaped depositions are also present.

Lagerstroemia microcarpa Wight (Figs. 35,36)

Seeds 5.0-8.0 x 2.0-3.0 mm, unilaterally winged with a pyramidal seed body. Spermoderm in lower magnification (Fig. 35 x200) shows polygonal cells arranged in irregularly reticulate pattern having thinner and raised radial walls and concave outer tangential walls. In higher magnification (Fig. 36 x1000) the grooves that separating the adjacent cells are not so conspicuous.

Lagerstroemia parviflora Roxb. (Fig. 37 x300)

Seeds 13-16 x 4.0-6.0 mm, unilaterally winged with a pyramidal seed body. Spermoderm shows sculpturing pattern resembling that of L. indica described above, but the depositions over the spermoderm is not so conspicuous in this species. Grooves between the adjacent cells are conspicuous, and the outer tangential walls are concave in outline.

Lawsonia inermis L. (Figs. 38, 39)

Seeds 2.0-2.5 x 0.5-1.0 mm, pyramidal. Primary sculpturing in the lower magnification (Fig. 38 x160) shows irregularly rugose ornamentation and the higher magnification (Fig. 39 x320) exhibits irregular projections all over the spermoderm surface.

Lythrum salicaria L. (Figs. 40, 41)

Seeds 1.0-1.5 x 0.48-0.6 mm, elliptical. Spermoderm in lower magnification is reticulate (Fig. 40 x80) and in the higher magnification (Fig. 41 x320) spermoderm cells conspicuous, elongated, forming a reticulam and cells are arranged end to end; radial walls uniformly thickened,

elevated; outer tangential walls collapsed, forming an elongated and wider lumina.

Lythrum tribracteatum Salzm. ex spreng. (Figs. 42, 43)

Seeds 0.58-0.7 x 0.43-0.52 mm, wide elliptic, both ends more or less pointed. Spermoderm in lower magnification (Fig. 42 xl80) shows papillose ornamentation throughout the surface, and in the higher magnification (Fig 43 xl200) the papillae appeared as mount shaped, having irregularly shaped flakes of deposition over its surface.

Nesaea brevipes Koehne (Figs. 44, 45)

Seeds 0.33-0.40 x 0.27-0.38 mm, suborbicular-ovate; spermoderm in lower magnification (Fig. 44 xl60) is reticulate; in higher magnification (Fig. 45 x640) spermoderm cells conspicuously hexagonal; radial walls raised, evenly thickened; outer tangential walls depressed to form wider and conspicuous lumina.

Nesaea lanceolate (Clarke) Koehne (Figs. 46,47).

Seeds 0.37-0.43 x 0.35-0.40 mm, ovate. Spermoderm in lower magnification shows irregularly reticulate sculpturing

pattern (Fig. 46 x160); in higher magnification it shows (Fig. 47 x640) inconspicuous spermoderm cells, forming an irregular reticulation due to the presence of undulate boundary walls.

Pemphis acidula Forst. (Figs. 48-50)

Seeds 3.0-3.5 x 1.5-2.5 mm, deltoid to cuneate compressed. Spermoderm in lower magnification (Fig. 49 x600) shows reticulate sculpturing pattern formed of polygonal or isodiametric cells. In the higher magnification (Fig. 50 x1200) the cells clearly indicates convex projections having a dimpled top, and which is overlained by parallelly oriented fibrillar striations.

Rotala cordata Koehne (Figs. 51, 52)

Seeds 0.45-0.52 x 0.32-0.37 mm, ovoid. Spermoderm in lower magnification is reticulate (Fig. 51 x160) and in higher magnification (Fig. 52 x640) spermoderm cells are rectangular with thin elevated radial walls enclosing relatively larger lumen formed due to the depression or a collapse of outer tangential walls.

Rotala densiflora (Roth. ex Roem. & Schult.) Koehne  
(Figs. 53, 54)

Seeds 0.4-0.6 x 0.32-0.37 mm, ovate. Spermoderm in lower magnification (Fig. 53 x150) is striate; in higher magnification (Fig. 54 x1200) spermoderm cells conspicuous, elongate; radial walls relatively thickened, raised, with obscure ornamentations; outer tangential walls narrow, depressed, forming an elongated narrow lumen, surface with irregularly striated secondary sculpturing.

Rotala fimbriata Wight (Figs. 55, 56)

Seeds 0.95-1.2 x 0.65-0.7 mm, ovoid-oblong. Spermoderm cells in lower magnification (Fig. 55 x80) are lineate, finely beaded, the tubercles arranged parallel to one another; in higher magnification (Fig. 56 x640) spermoderm cells are conspicuous, quadrangular, arranged end to end in longitudinal axis; radial walls unevenly thickened, elevated, giving the spermoderm surface the beaded appearance; outer tangential walls depressed, forming more or less quadrangular lumina.

Rotala illecebroides (Wight) Koehne (Figs. 57, 58)

Seeds 0.35-0.37 x 0.2-0.23 mm, ovate. Spermoderm in lower magnification somewhat smooth in appearance

(Fig. 57 x320); in higher magnification (Fig. 58 x2500) the surface shows rugose ornamentation. The spermoderm cells are irregular in shape; the radial walls raised, variously thickened and shows papillose appearance at the cell corners; outer tangential walls depressed, forming larger lumen.

Rotala indica (Willd.) Koehne (Figs. 59, 60)

Seeds 0.35-0.43 x 0.18-0.2 mm, ovate-oblong. Spermoderm in lower magnification (Fig. 59 x320) are lineate; the elevated radial walls appear as parellel lines. In higher magnification (Fig. 60 x1250) the spermoderm cells are conspicuous, elongate, arranged end to end; the radial walls are uniformly thickened, slightly raised; outer tangential walls depressed, forming narrow, elongate lumen.

Rotala macrandra Koehne (Figs. 61, 62)

Seeds 0.48-0.52 x 0.2-0.28 mm, ellipsoid. Spermoderm appears striate in lower magnification (Fig. 61 x240), owing to the longitudinal ridges of the radial walls and the troughs of the lumina. In the higher magnification (Fig. 62 x1200) spermoderm cells are conspicuous, long-fibriform and arranged end to end; the radial walls thicker, rod-like and wider than the slit-like lumen.



Rotala malampuzhensis R.V. Nair ex Cook (Figs. 63, 64)

Seeds 0.52-0.63 x 0.4-0.5 mm, ovoid. Spermoderm in lower magnification is smooth (Fig. 63 x160); in higher magnification (Fig. 64 x640) the spermoderm cells are quadrangular and almost squarish in outline having the corners with slightly convex papillose projections.

Rotala mexicana Cham. & Schlecht. (Figs. 65, 66)

Seeds 0.25-0.28 x 0.15-0.18 mm, suborbicular. Spermoderm in lower magnification (Fig. 65 x600) shows regular papillose primary sculpturing pattern. In the higher magnification (Fig. 66 x2200) it shows convex topped papillae much raised from the general surface and at its end it possesses many ciliate hairs.

Rotala occultiflora Koehne (Figs. 67, 68)

Seeds 0.4-0.45 x 0.2-0.23 mm, suboblong. Spermoderm in lower magnification is reticulate (Fig. 67 x320), reticula arranged in parallel rows in the longitudinal axis of the seed; in the higher magnification (Fig. 68 x1250) the spermoderm cells are conspicuous, elongate; the radial walls

comparatively thinner and slightly raised; the outer tangential walls intact, much wider, flat and the surface showing obscure ornamentations.

Rotala rosea (Poirot) C.D.K. Cook et Hara (Figs. 69, 70)

Seeds 0.35-0.42 x 0.32-0.35 mm, ovoid. Spermoderm in lower magnification (Fig. 69 x320) shows reticulate ornamentation pattern and in higher magnification (Fig. 70 x1200) spermoderm cells are conspicuously pentangular or hexangular, forming a network; the radial walls thick and raised; outer tangential walls depressed, surface with striated secondary sculpturing.

Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne (Figs. 71, 72).

Seeds 0.45-0.47 x 0.27-0.32 mm, ellipsoid. Spermoderm in lower magnification shows reticulate ornamentation (Fig. 71 x160), reticula arranged parallel to one another into the longitudinal axis of the seed; in higher magnification (Fig. 72 x1250) the spermoderm cells are conspicuous and elongate; the radial walls evenly thickened and raised; the outer tangential walls intact, depressed and the surface with striated secondary sculpturing.

Rotala rubra (Buch.-Ham. ex D.Don) Hara (Figs. 73,74)

Seeds 0.33-0.45 x 0.27-0.35 mm, semi-spherical. Spermoderm in lower magnification is (Fig. 73 x160) reticulate; in higher magnification (Fig. 74 x760) spermoderm cells are conspicuously polygonal in outline, elongated; the radial walls stout and slightly projected; the outer tangential walls slightly depressed, forming more or less elongated lumina. A few strands of wall materials are irregularly traverse the lumina.

Rotala subrotunda (Wall. ex Clarke) Koehne (Figs. 75, 76)

Seeds 0.35-0.37 x 0.18-0.2 mm, ellipsoid. Spermoderm in lower magnification is striate (Fig. 75 x320); in higher magnification (Fig. 76 x1250) the spermoderm cells are elongate, fibriform with relatively thicker radial walls and narrow or even indistinct slit-like lumen. The cells form a continuous weave and with slightly bulb-shaped cell endings.

Rotala verticillaris L. (Figs. 77, 78)

Seeds 0.3-0.38 x 0.2-0.25 mm, oblong-ovoid. Spermoderm in lower magnification (Fig. 77 x160) is reticulate in appearance; in the higher magnification (Fig. 78 x2500)

spermoderm cells are rhomboidal in outline; boundary walls channelled; the outer tangential walls convex.

Woodfordia fruticosa (L.) Kurz (Figs. 79,80)

Seeds 0.6-0.8 x 0.4-0.5 mm, linear-ovate. Spermoderm surface in the lower magnification (Fig. 79 x160) shows rugose ornamentation having thickened radial walls; in the higher magnification (Figs. 80 x2600) the surface shows striate secondary sculpturing pattern and some of the areas show foveolate depressions also.

#### E. DISCUSSION

The shape and size of the seeds of different species of the Indian Lythraceae are variable. Seeds of all but a few species are triangular-ovoid, ovoid, ellipsoid and linear-ovate in outline. Seeds of Pemphis are discoid, and those of Lawsonia are pyramidal. Lagerstroemia uniquely has unilaterally winged seeds with a pyramidal seed body and revolute cotyledons. The seeds of Lythraceae range in length from 0.25 mm to 16 mm and in width from 0.15 mm to 6.0 mm. Ultrastructure of the cells of the seed coat of different taxa show distinctive pattern and they are more or less specific. The surface pattern of the seeds are rugose,

reticulate, lineate or striate in most species. Tubercles or ridges (enhanced striation) may result from differential thickenings of the radial walls.

Rotala seeds range in length from 0.25 to 1.2 mm and in width from 0.15 mm to 0.7 mm. The surface pattern is striate, lineate, rugose or reticulate. The testa is made up of several rows of cells arranged end-to-end in the longitudinal axis of the seed is a unique feature of the genus (except in R. rosea). The seeds of R. fimbriata (Figs. 55, 56) are larger (1.6 mm long) with a lineate surface pattern which are finely beeded. Rotala densiflora (Figs. 53, 54), R. macrandra (Figs. 75, 76), and R. subrotunda (Figs. 75, 76) form a relatively homogeneous group based on seed surface characteristics. The surface pattern is striate and the cells of the seed coat are elongate and fibriform with thick radial walls and narrow or slit-like lumen. Rotala rosea (Figs. 69, 70), R. cordata (Figs. 51, 52) and R. rubra share a somewhat similar seed coat morphology, with a reticulate network like pattern, and they stand somewhat by themselves. The individual cells of R. cordata are rectangular and having a large and deep lumen. The cells of R. rubra are polygonal in outline and having more or less elongated and shallow lumen. Rotala indica (Figs. 59, 60) and R. occultiflora (Figs. 67, 68) are

unlike any other in the genus. In both the species, the radial walls are thin, uniformly thickened and slightly raised, which are appearing as fine parallel lines traversing the surface lengthwise. Rotala illecebroides (Figs. 57, 58) and R. malampuzhensis (Figs. 63, 64) have seeds that are extremely smooth, almost featureless, except under high magnification. In higher magnification their cell corners exhibiting convex papillose projections, while in R. mexicana (Figs. 65, 66) regular papillose sculpturing pattern is visible in lower magnification itself. The seed-coat surface pattern of R. verticillaris (Figs. 77, 78) is reticulate. The cells of the seed coat are rhomboidal with channelled radial walls and convex outer tangential walls. The seeds of R. rotundifolia (Figs. 71, 72) is with a rugose surface pattern. The cells of the seed coat are elongated with thin radial walls and a large lumen.

The spermoderm sculpturing pattern and the seed coat cell structure can be used as a tool to delimit various species complexes within the genus Rotala. Rotala densiflora seeds having striate surface pattern and elongate, fibriform seed coat cells with thick radial walls and a slit-like lumen can easily be distinguished from its closely allied species, R. rosea having reticulate, net-work like surface pattern with pentangular or hexangular seed

coat cells have large and deep lumen. The R. macrandra - R. rotundifolia complex can easily be separated by the striate versus rugose surface pattern and long fibriform seed coat cells with thick, rod-like radial walls and a slit-like lumen versus elongated seed coat cells with thin radial walls and a large lumen. Rotala indica with lineate seed coat pattern and elongated seed coat cells with moderately sized lumen shows distinct spermoderm sculpturing characters than the closely allied species R. subrotunda with striate surface pattern and long fibriform cells with thick radial walls that nearly fill the lumina.

Ammannia seeds are triangular-ovoid, ovoid or rectangular in shape. The seeds range in length from 0.25 mm to 0.57 mm and in width from 0.2 mm to 0.42 mm. The surface pattern is rugose, rugose-reticulate, reticulate or smooth. The seed coat cells that are arranged irregularly in a net-work like pattern is a reliable character by which the genus can be differentiated from Rotala, in which the cells are arranged end to end in definite parallel rows. Ammannia auriculata (Figs. 19, 20) clearly stands alone within the genus Ammannia. The seeds are more or less rectangular in outline and the surface is very smooth and almost featureless, except under high magnification. The cells of the seed coat are elongated with channelled radial walls and more or less convex outer tangential walls that

have scattered pits throughout its surface. Ammannia desertorum, which otherwise appears to have closely related to A. auriculata, stand apart noticeably from it on the basis of seed characteristics. The seeds of A. desertorum (Figs. 23, 24) are triangular-ovoid in shape, and the surface pattern is rugose-reticulate. The radial walls are moderately thickened and raised, and the outer tangential walls depressed to form narrow lumen. Ammannia multiflora (Figs. 25, 26), A. nagpurensis (Figs. 27, 28) and A. senegalensis (Figs. 31, 32) have seeds with reticulate surface pattern and the individual cells have a large deep lumen. The radial walls of A. nagpurensis are unevenly thickened due to the presence of convex papillae at the cell corners. The radial walls of both A. multiflora and A. senegalensis are uniformly thickened and evenly raised, but on its surfaces A. multiflora possesses numerous scattered pores.

Nesaea seeds are ovoid to suborbicular in outline with a convex outer surface and concave inner surface. The size of the seeds vary from 0.33-0.43 x 0.27-0.4 mm. The surface pattern in reticulate. The spermoderm of Nesaea brevipes (Figs. 44, 45) has shown that the epidermal cells are conspicuously hexagonal with uniform boundaries, where as in N. lanceolata (Figs. 46, 47) the cells are inconspicuous with irregular boundaries.



The seeds of Lythrum (Figs. 40-43) range in length from 0.58 mm to 1.5 mm and in width from 0.43 to 0.6mm. The seeds are elliptical to broadly elliptical or slightly fusiform. In L. salicaria (Figs. 40, 41), the surface pattern is reticulate with conspicuous and elongate cells. The radial walls are uniformly thickened and raised, and the lumen is elongated and wide. Lythrum tribracteatum (Figs. 42, 43) shows papillose surface pattern.

Woodfordia fruticosa (Figs. 79, 80) has small (0.6-0.8 x 0.4-0.5 mm) oblong-truncate to linear-ovate seeds. The surface pattern appears rugose in lower magnification, and finely striate secondary sculpturing is visible in higher magnification.

The seeds of Pemphis acidula (Figs. 48-50), which are deltoid to cuneate-compressed, are 3-3.5 x 1.5-2.5 mm in size. The seed coat is reticulate with polygonal or isodiametric cells that fit together in a honeycomb-like pattern.

Lawsonia inermis (Figs. 38, 39) has pyramidal seeds that are 2-2.5 x 0.5-1 mm in size. The surface pattern is irregularly rugose, being possessed by irregular projections all over the surface.

Lagerstroemia uniquely has unilaterally winged seeds with a pyramidal seed body, and are 5-16 x 2-6 mm in size. The seed coat surfaces appear as reticulate. The spermoderm cells are polygonal in shape, and have concave outer tangential walls. In L. indica (Figs. 35, 36) and L. parviflora (Figs. 37), the anticlinal boundaries are channelled while in L. microcarpa (Figs. 35, 36) the boundary walls are raised. Numerous and conspicuous wax depositions are present at the cell junctions of L. indica. while in L. parviflora it is not so frequent and in L. microcarpa wax depositions are absent.

Table 2. List of vouchers of species studied. Unless otherwise indicated, all vouchers are deposited at the Central National Herbarium, Howrah (CAL).

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Ammannia auriculata Willd.

Rajasthan, Ganganagar, Roy 5029

Ammannia baccifera L.

West Bengal, Calcutta, Brace Bridge, Mathew 13109

Ammannia desertorum Blatt. & Hallb.

Pakistan, Sindh, Sabnis B 1150 (BLAT)

Ammannia multiflora Roxb.

Punjab, Thomson s.n.

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(Table 2 Contd .....)

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Ammannia nagpurensis Mathew & Nayar

Maharashtra, Nagpur, Subramanyam, 4717

Ammannia octandra L.

Tamil Nadu, Madurai, Subramanyam 5755

Ammannia senegalensis Lamk.

Maharashtra, Khandala, Santapau 4364 (BLAT)

Lagerstroemia indica L.

West Bengal, Burdwan, Banerjee 152

Lagerstroemia microcarpa Wight

Tamil Nadu, Coimbatore, Anamalais, Brandis s.n.

Lagerstroemia parviflora Roxb.

Tripura, Debberman 383

Lawsonia inermis L.

Karnataka, Shimoga, Meebold 6824

Lythrum salicaria L.

Kashmir, Thomson s.n.

Lythrum tribracteatum Salzm. ex Spreng.

Kashmir, Baramula, Meebold 4620

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(Table 2 Contd .....)

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Nesaea brevipes Koehne

Pen. Ind. Or., Wight 981

Nesaea lanceolata (Heyne ex Clarke) Koehne

Mysore and Karnatic, Thomson s.n.

Pemphis acidula J.R. & G. Forst.

South Andamans, Jain & Balakrishnan 6090

Rotala cordata Koehne

Orissa, Ganjam, Gamble 14071

Rotala densiflora (Roth ex Roemer & Schult.) Koehne

Maharashtra, Mahabaleshwar, Mathew 1350

Rotala fimbriata Wight

Karnataka, Mandya, Kesavamurthy & Prakash 457

Rotala illecebroides Koehne

Madhya Pradesh, Baster, Subramanyam 7230

Rotala indica (Willd.) Koehne

West Bengal, Burdwan, Kachroo s.n.

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(Table 2 Contd .....)

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Rotala macrandra Koehne

Bombay Presidency, Gibson, s.n.

Rotala malampuzhensis R.V. Nair ex C.D.K. Cook

Karnataka, Mysore, Sundararaghavan 90407

Rotala mexicana Cham. & Schlecht.

Uttar Pradesh, Bahraich, Dharampur, Panigrahi & Misra 6452

Rotala occultiflora Koehne

Maharashtra, Thana, Billore 113293

Rotala rosea (Poirot) C.D.K. Cook ex Hara

West Bengal, Howrah, Bennet 488

Rotala rotundifolia (Buch. - Ham. ex Roxb.) Koehne

West Bengal, Cooch Bihar, Banerjee 15260

Rotala rubra (Buch. - Ham. Ex D. Don) Hara

West Bengal, Siliguri, CAL. Acc. No. 175889

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(Table 2 Contd .....)

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Rotala subrotunda (Wallich ex Kurz) Koehne

Burma, Mclelland, s.n.

Rotala verticillaris L.

Tamil Nadu, Puducotai, Ramamurthy 53744

Woodfordia fruticosa (L.) Kurz

Manipur, Boishing, Watt 6735

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Figs. 19 - 24. Seeds of Ammannia

19 & 20. Ammannia auriculata

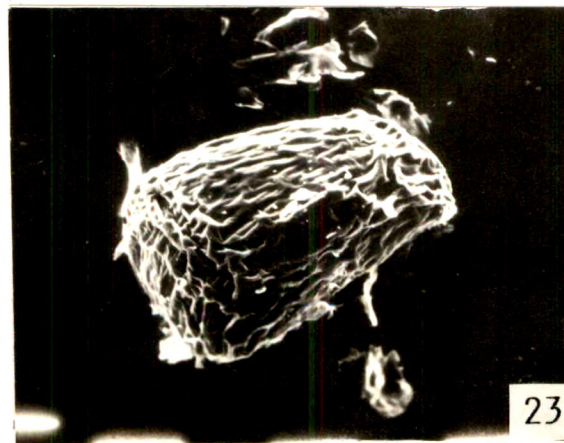
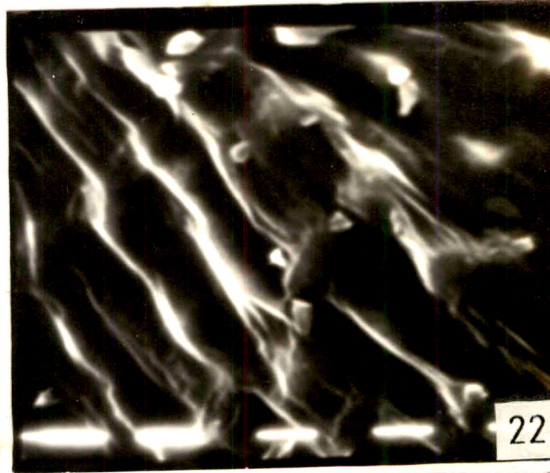
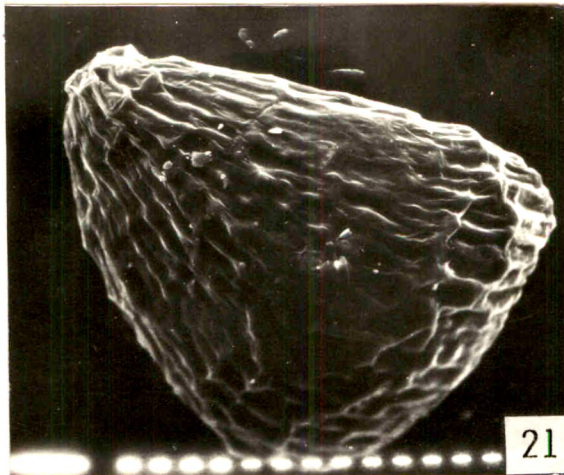
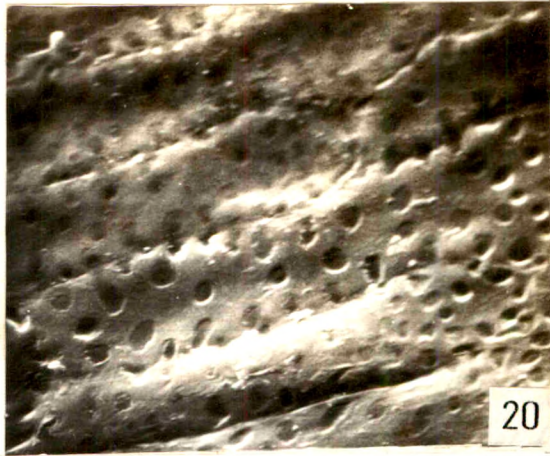
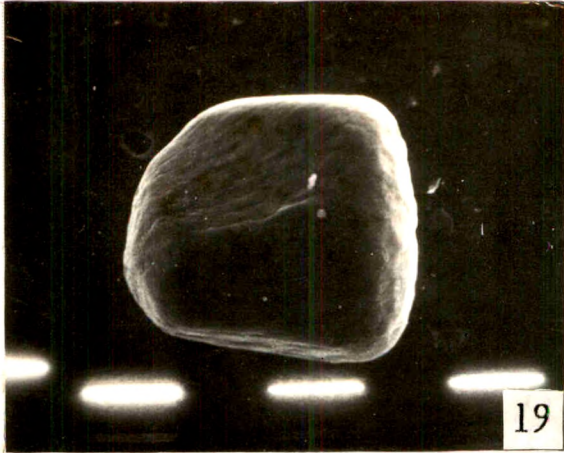
19 - Seed x160  
20 - Seed coat x1250

21 & 22 Ammannia baccifera

21 - Seed x320  
22 - Seed coat x1250

23 & 24 Ammannia desertorum

23 - Seed x160  
24 - Seed coat x640





Figs. 25 - 30. Seeds of Ammannia

25 & 26 Ammannia multiflora

25 - Seed x320

26 - Seed coat x640

27 & 28 Ammannia nagpurensis

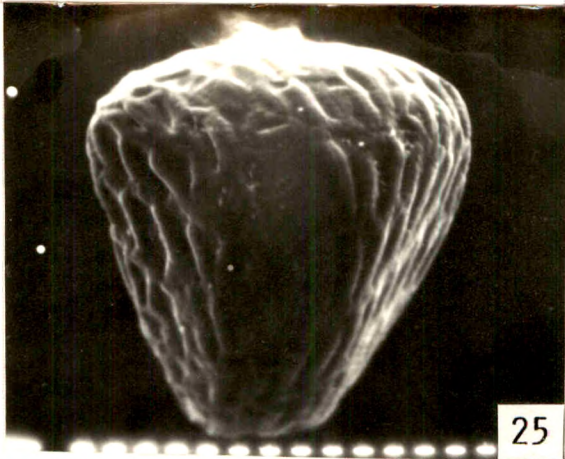
27 - Seed x320

28 - Seed coat x1250

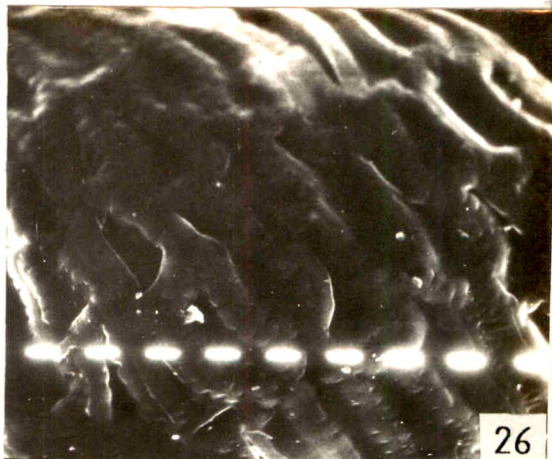
29 & 30 Ammannia octandra

29 - Seed x160

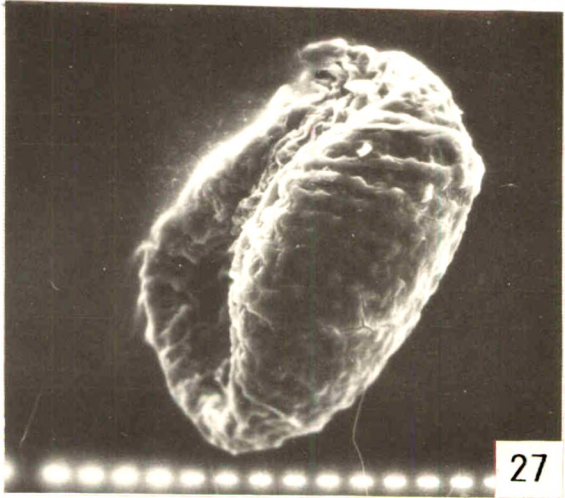
30 - Seed coat x640



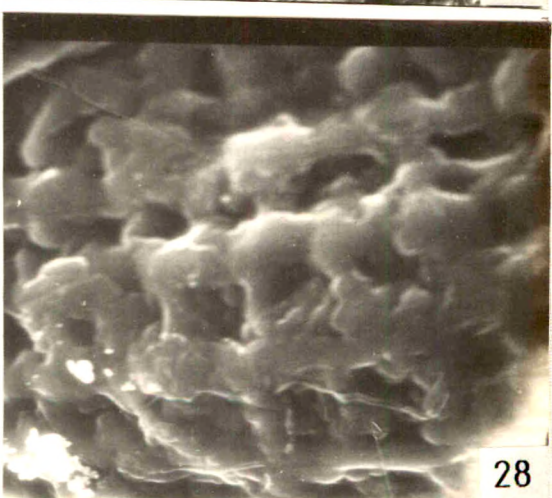
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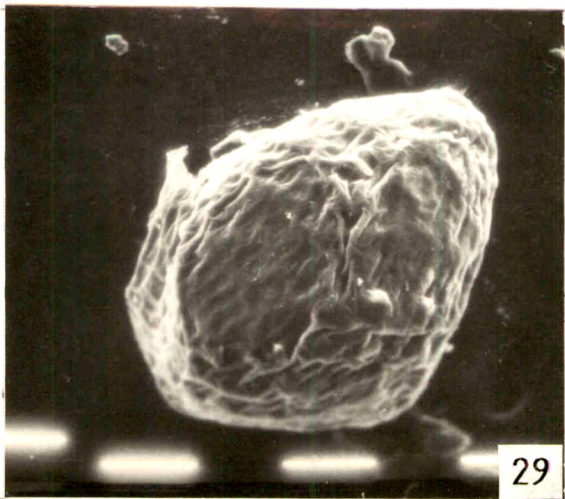
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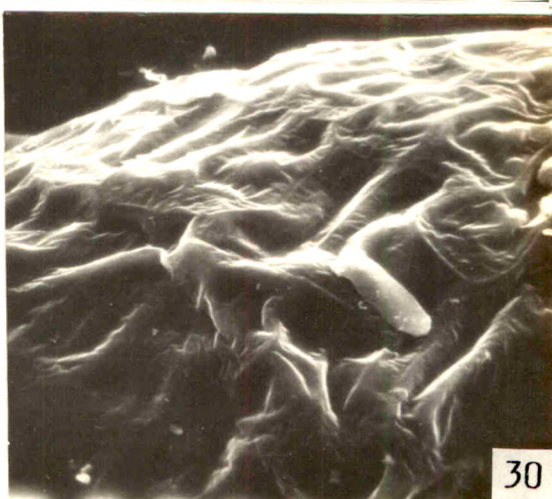
27



28



29



30

Figs. 31 - 36. Seeds of Ammannia and Lagerstroemia

31 & 32 Ammannia senegalensis

31 - Seed x160  
32 - Seed coat x640

33 & 34 Lagerstroemia indica

33 - Seed coat x260  
34 - Seed coat surface x1000

35 & 36 Lagerstroemia microcarpa

35 - Seed coat x100  
36 - Seed coat surface x1000



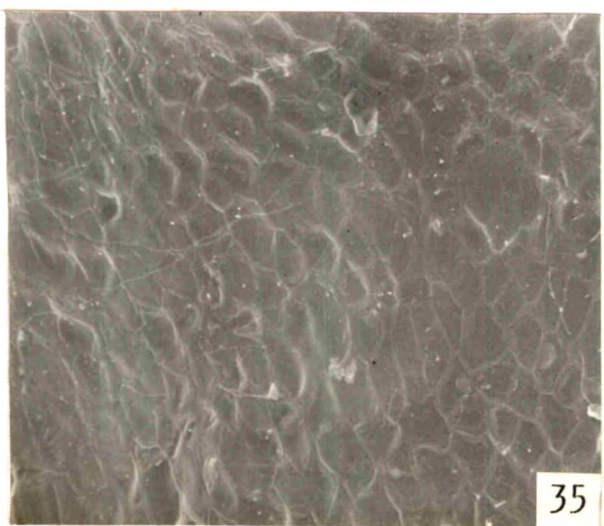
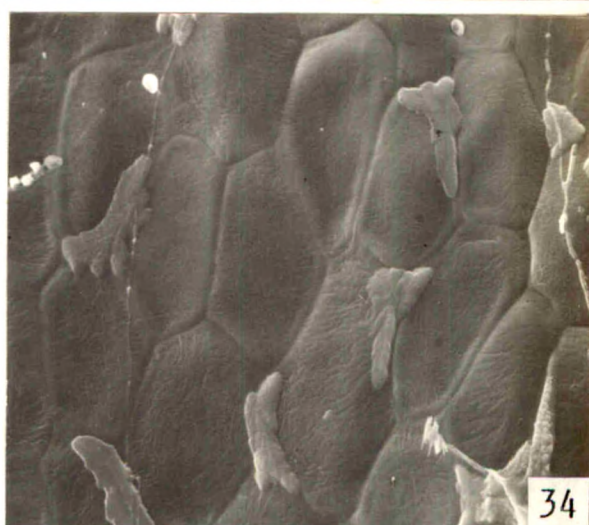
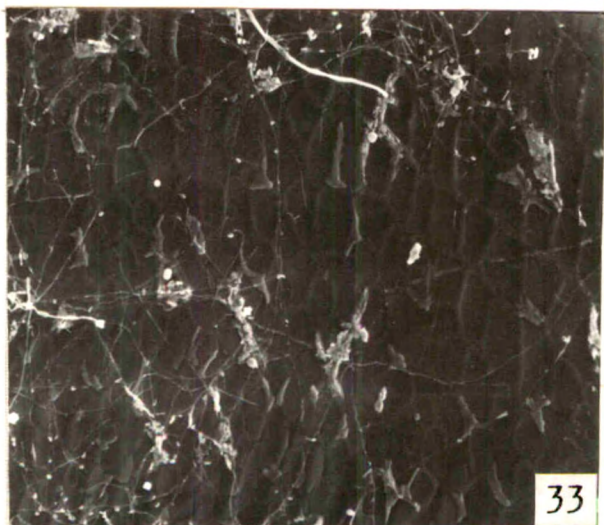
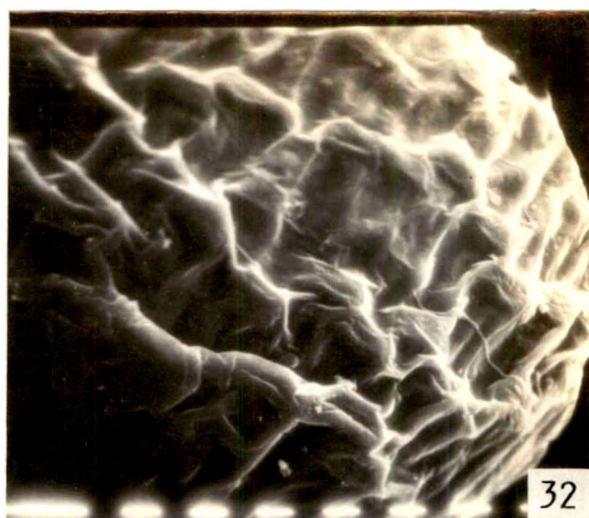
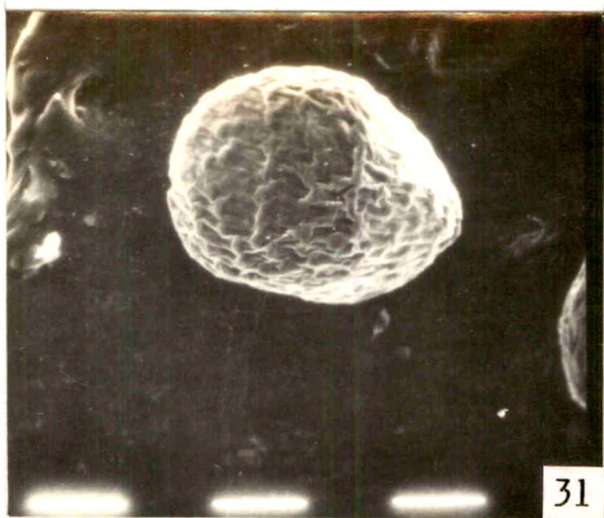


Fig. 37. Lagerstroemia parviflora  
Seed coat surface x300

Figs. 38 & 39 Lawsonia inermis  
38 - Seed coat surface x160  
39 - Seed coat surface x320

Figs. 40 & 41 Lythrum salicaria  
40 - Seed x80  
41 - Seed coat x320

Fig. 42. Lythrum tribracteatum  
Seed x180



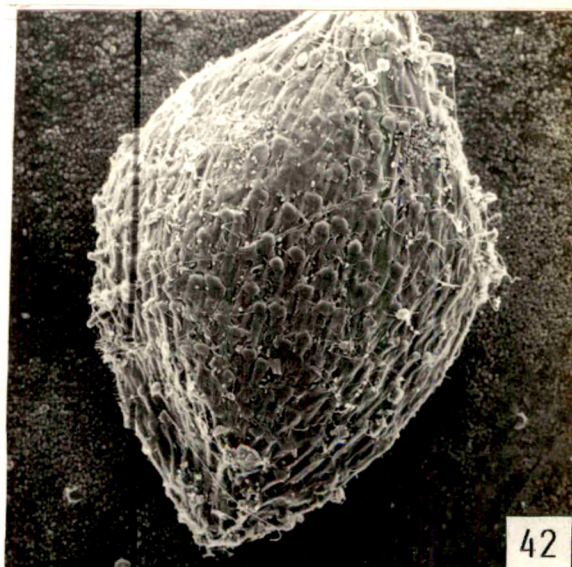
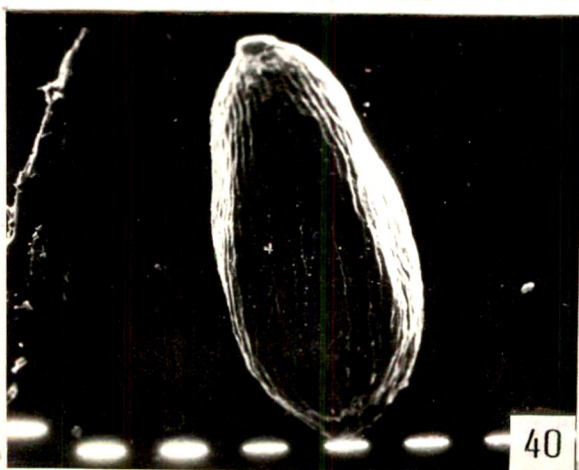
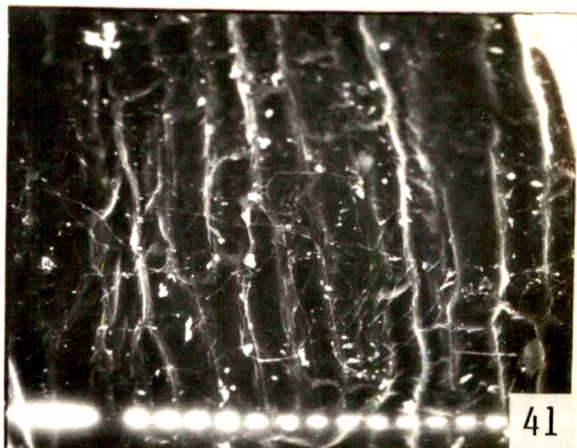
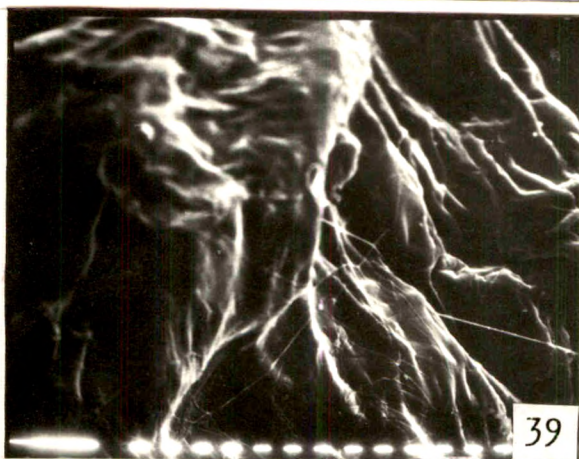
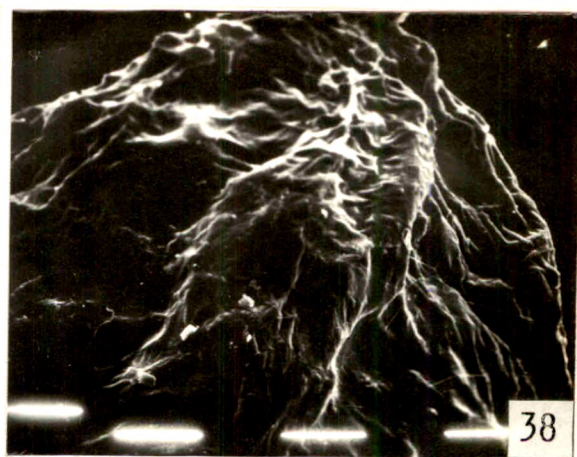


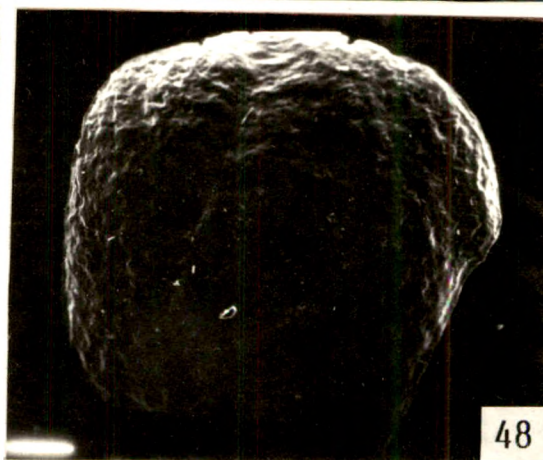
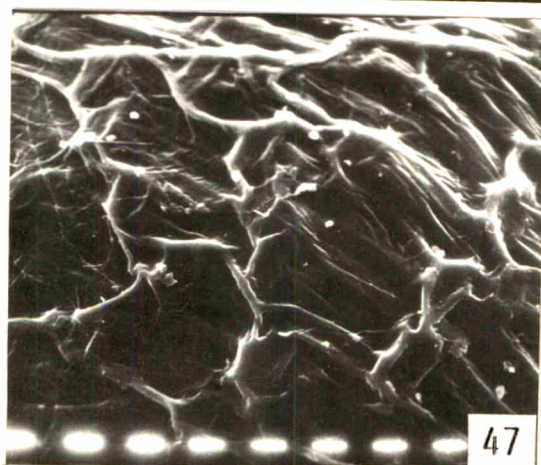
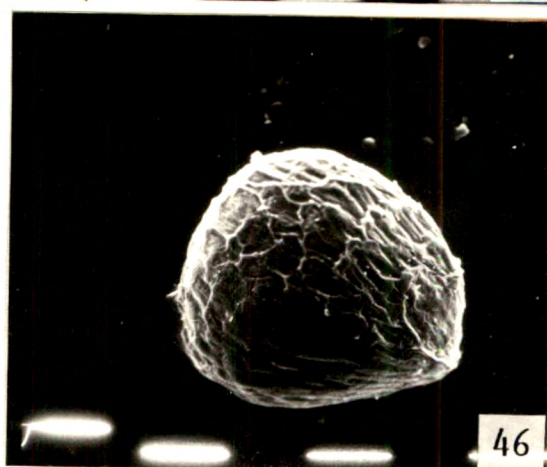
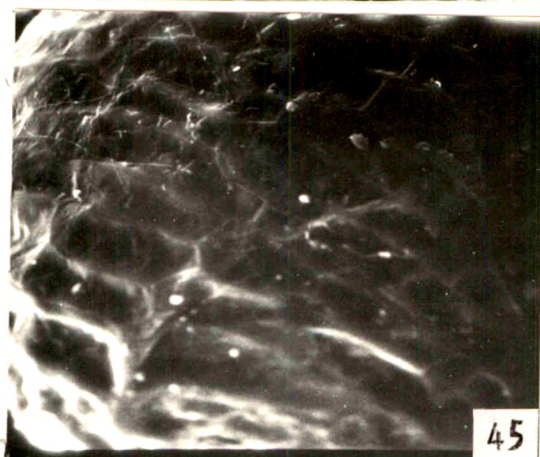
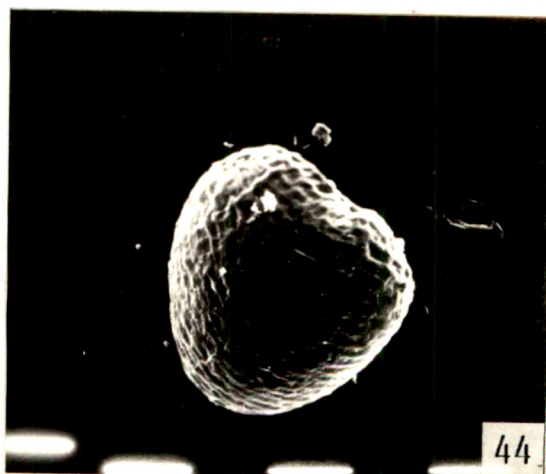
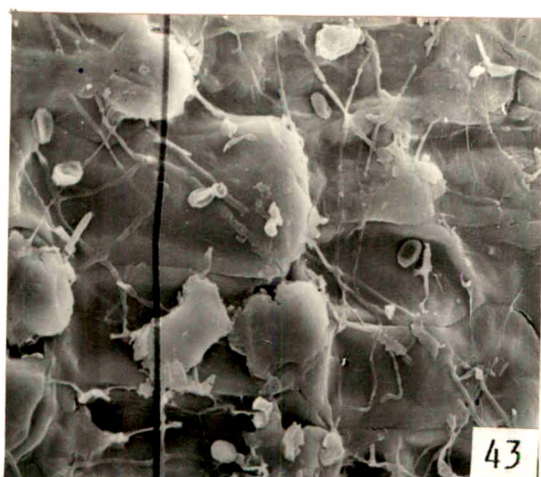
Fig. 43. Lythrum tribracteatum  
Seed coat surface x1200

Figs. 44 & 45. Nesaea brevipes  
44 - Seed x160  
45 - Seed coat x640

Figs. 46 & 47. Nesaea lanceolata  
46 - Seed x160  
47 - Seed coat x640

Fig. 48. Pemphis acidula  
Seed x40







Figs. 49 - 54. Seeds of Pemphis and Rotala

49 & 50. Pemphis acidula

49 - Seed coat x600

50 - Seed coat surface x1200

51 & 52. Rotala cordata

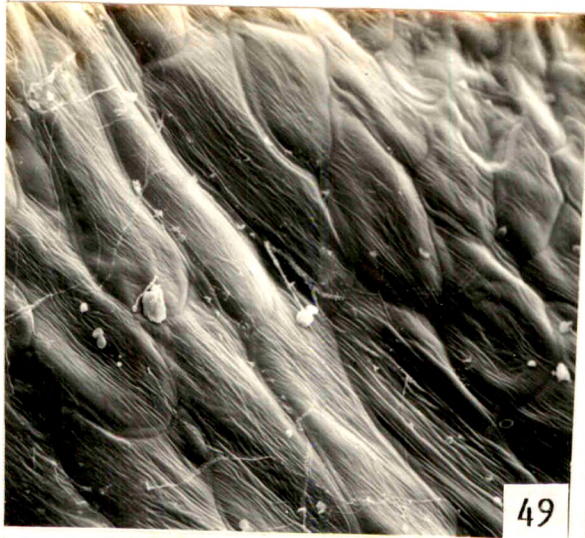
51 - Seed x160

52 - Seed coat x640

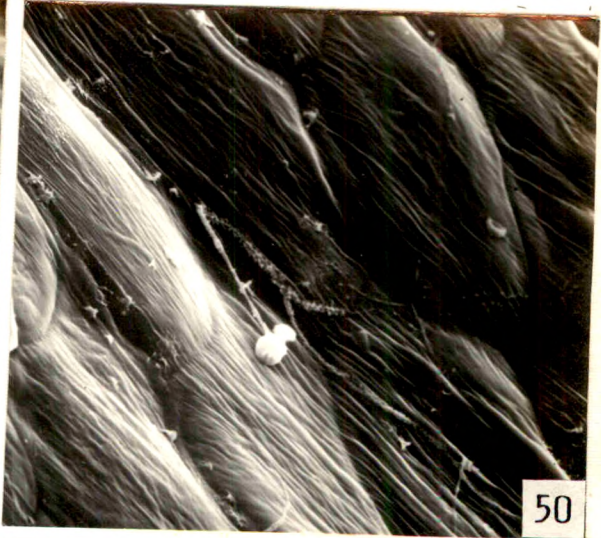
53 & 54 Rotala densiflora

53 - Seed x150

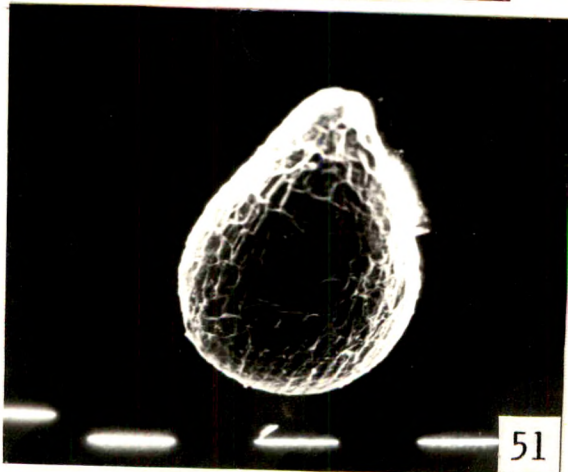
54 - Seed coat x1200



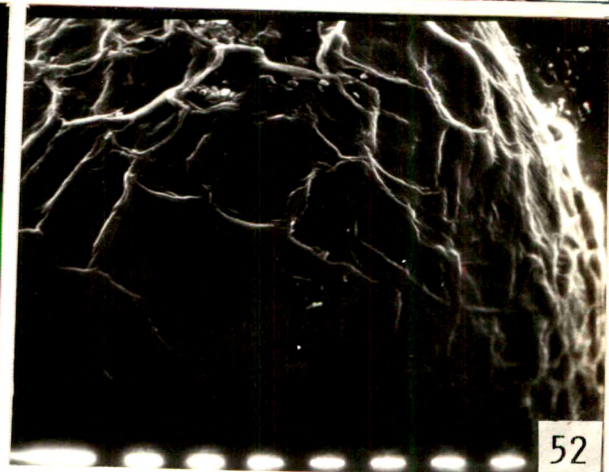
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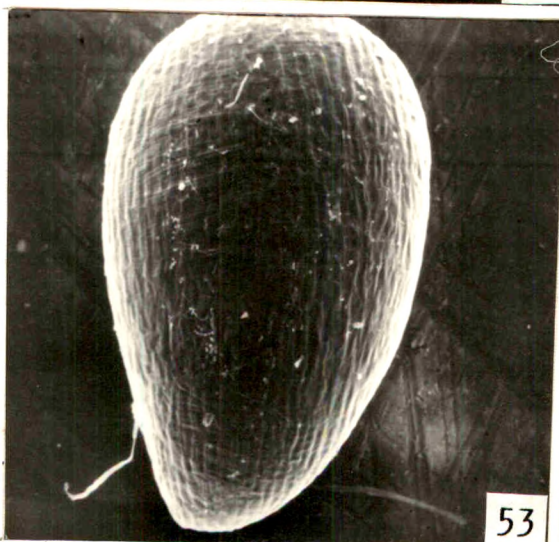
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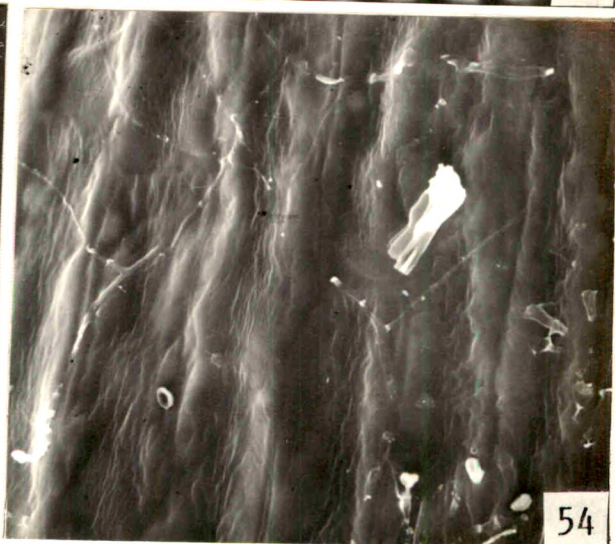
51



52



53



54

Figs. 55 - 60. Seeds of Rotala

55 & 56. Rotala fimbriata

55 - Seed x80

56 - Seed coat x640

57 & 58. Rotala illecebroides

57 - Seed x320

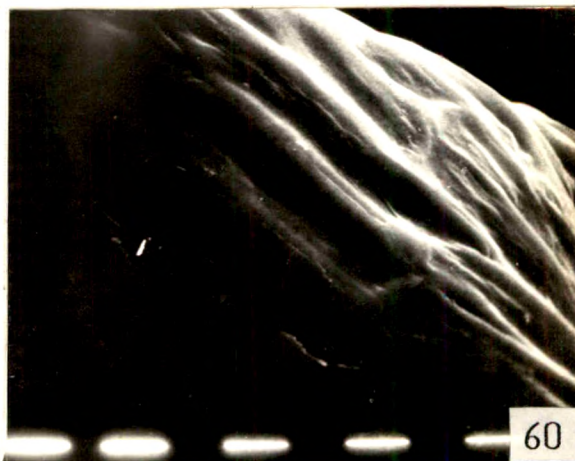
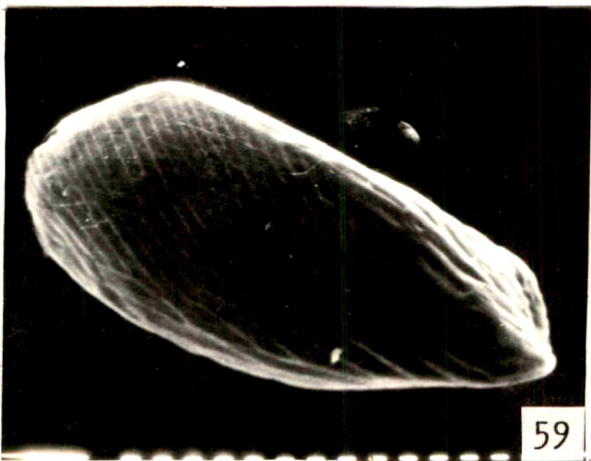
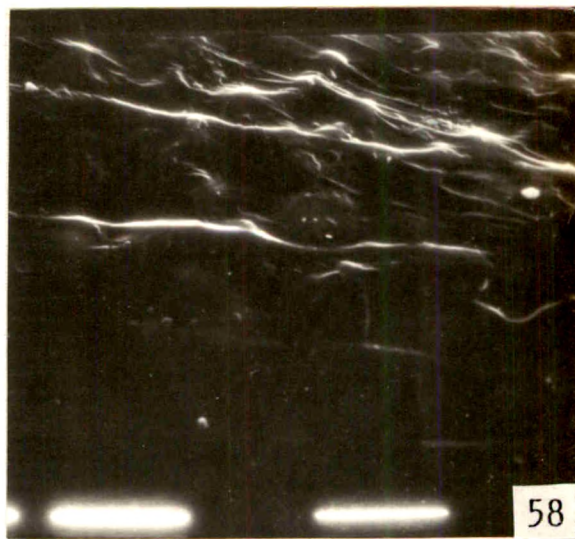
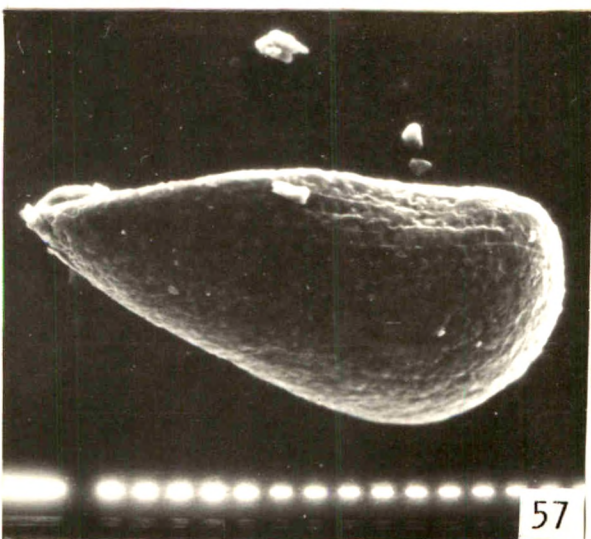
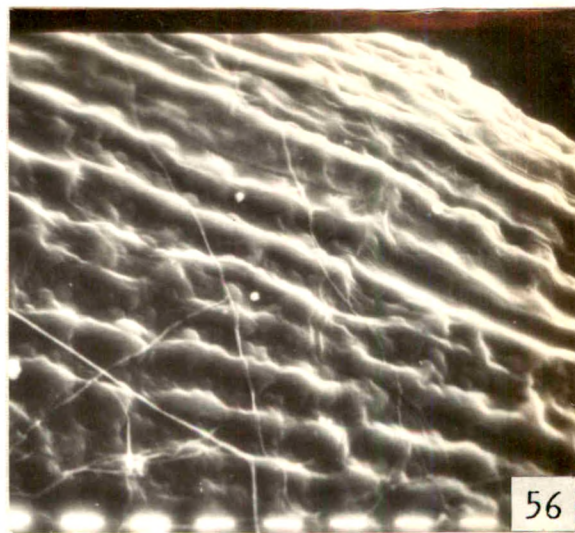
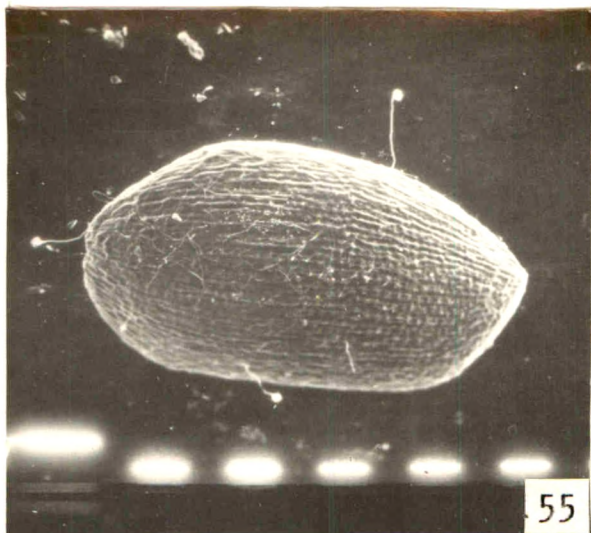
58 - Seed coat x2500

59 & 60. Rotala indica

59 - Seed x320

60 - Seed coat x1250





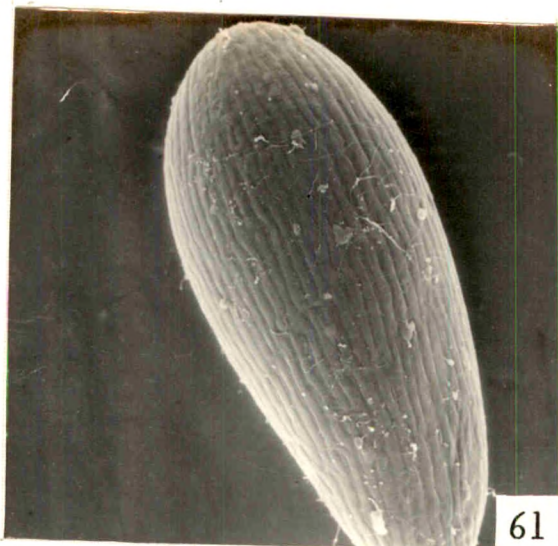
Figs. 61 - 66. Seeds of Rotala

61 & 62. Rotala macrandra  
61 - Seed x240  
62 - Seed coat x1200

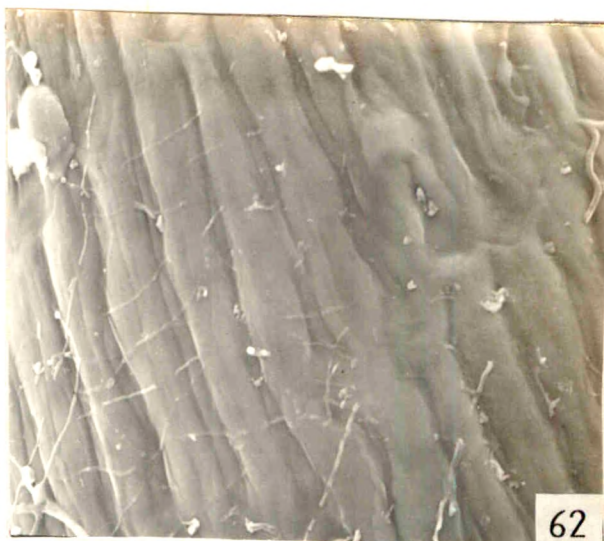
63 & 64. Rotala malampuzhensis  
63 - Seed x160  
64 - Seed coat x640

65 & 66. Rotala mexicana  
65 - Seed x600  
66 - Seed coat x2200

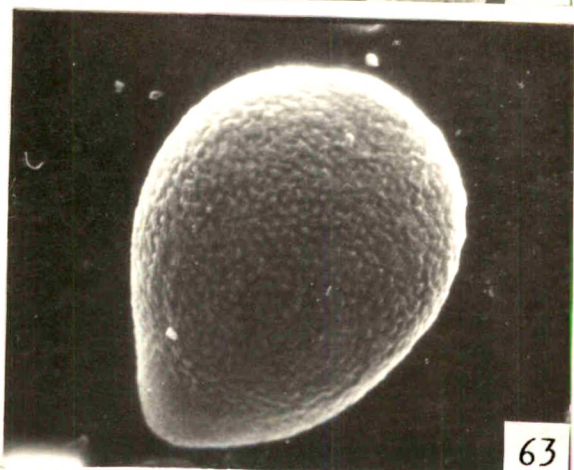




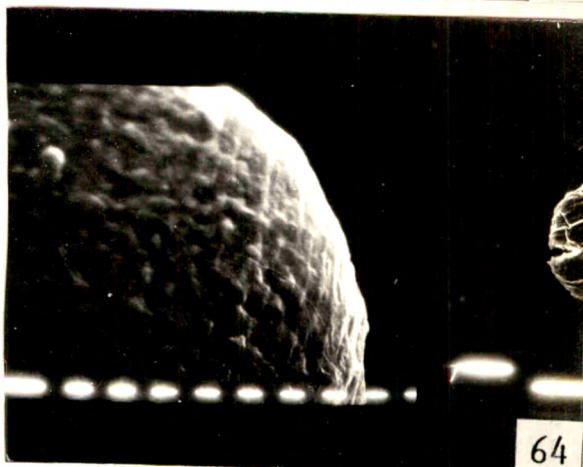
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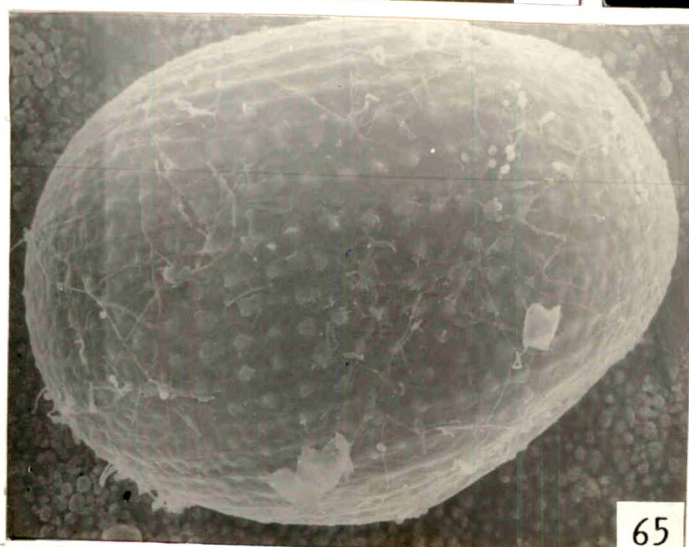
62



63



64



65



66

Figs. 67 - 70. Seeds of Rotala

67 & 68. Rotala occultiflora

67 - Seed x320

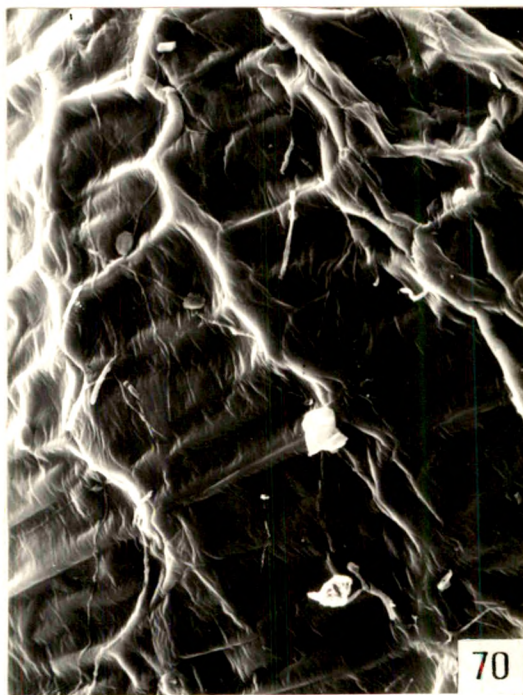
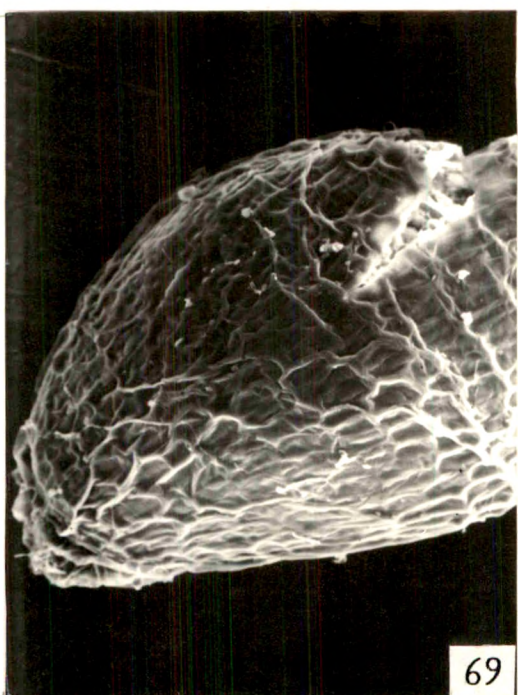
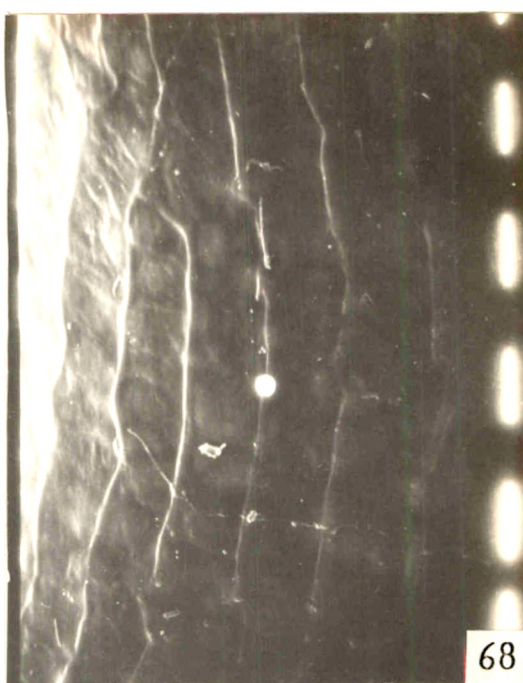
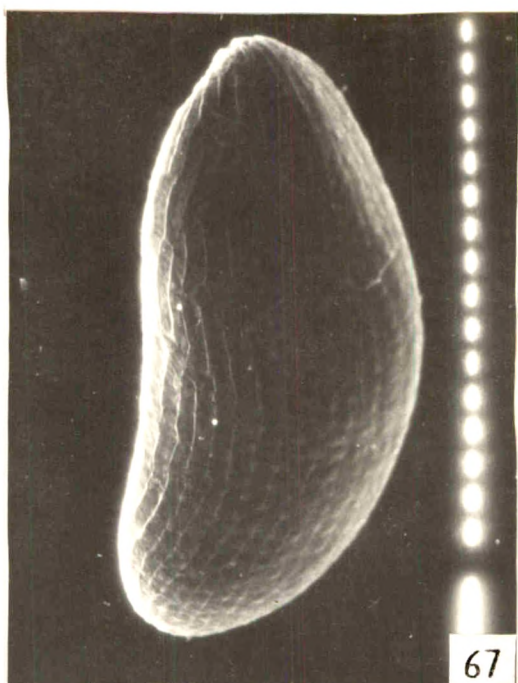
68 - Seed coat x1250

69 & 70. Rotala rosea

69 - Seed x320

70 - Seed coat x1200







Figs. 71 - 76. Seeds of Rotala

71 & 72. Rotala rotundifolia

71 - Seed x160

72 - Seed coat x1250

73 & 74. Rotala rubra

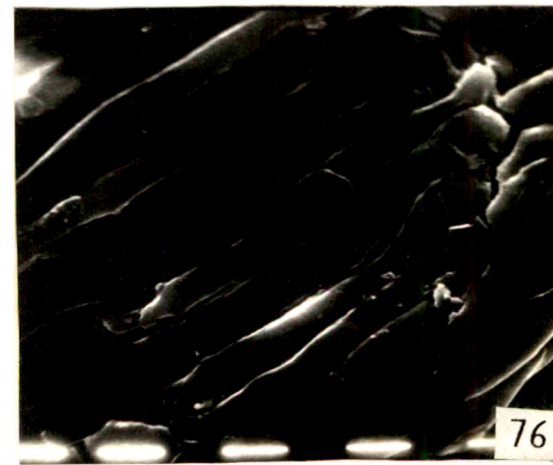
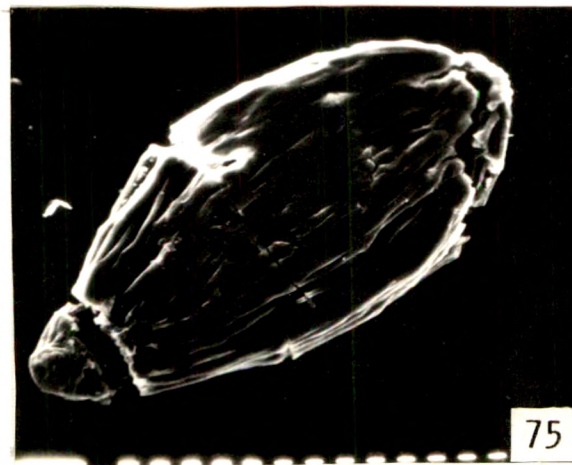
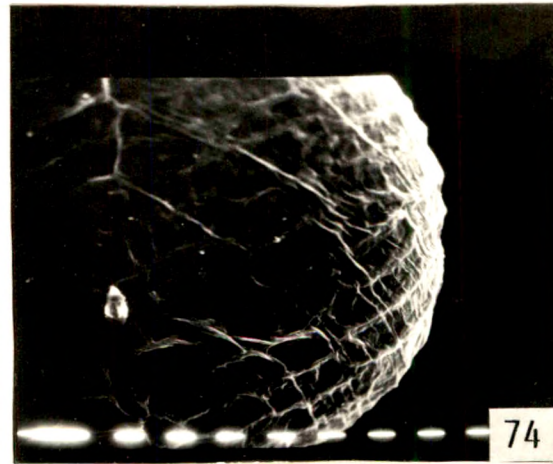
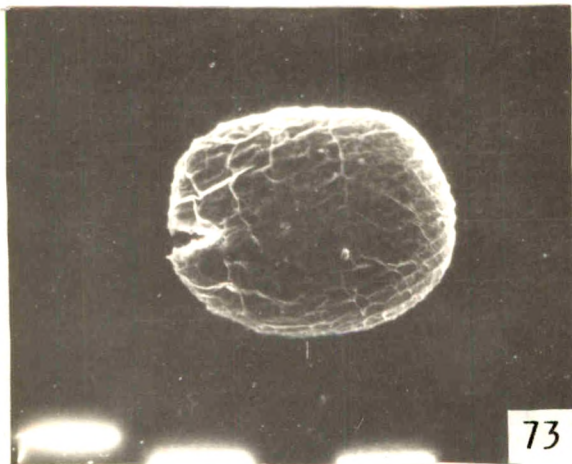
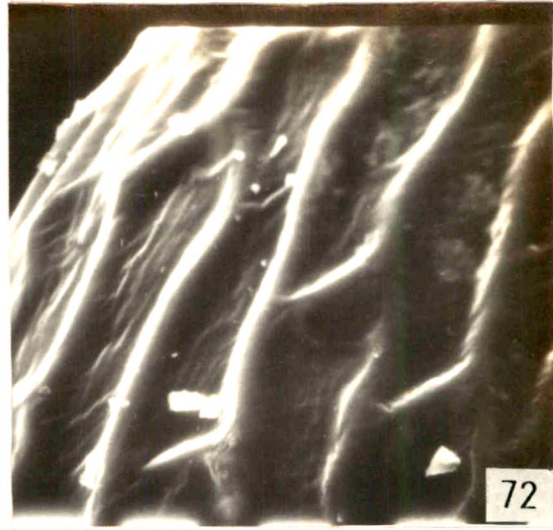
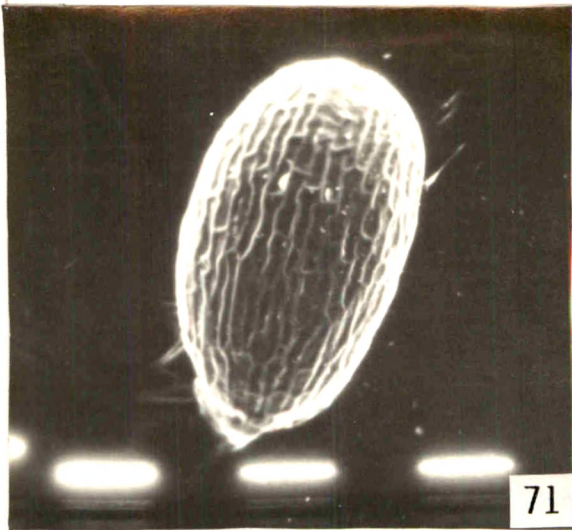
73 - Seed x160

74 - Seed coat x640

75 & 76. Rotala subrotunda

75 - Seed x320

76 - Seed coat x1250



Figs. 77 - 80. Seeds of Rotala and Woodfordia

77 & 78. Rotala verticillaris

77 - Seed x160

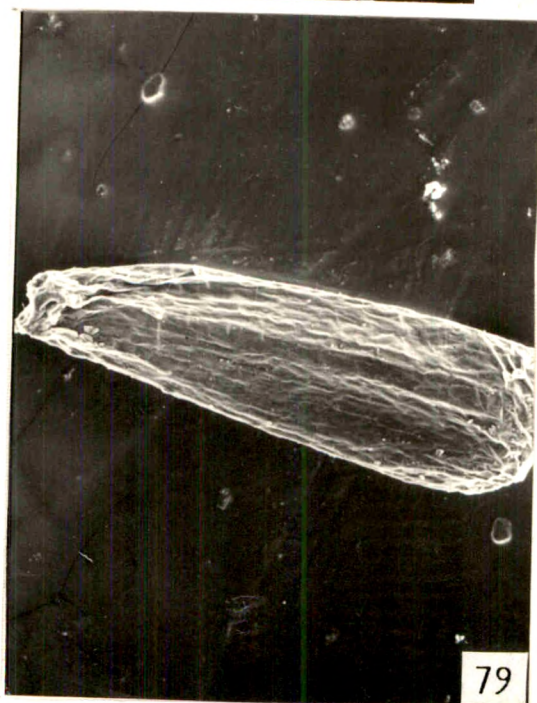
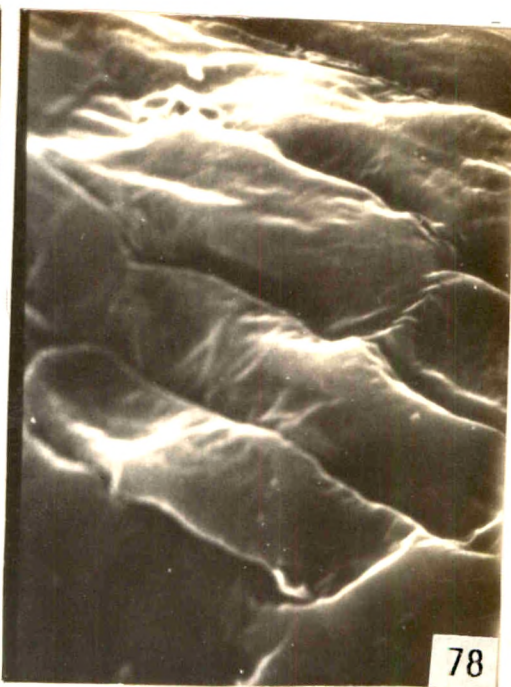
78 - Seed coat x1250

79 & 80. Woodfordia fruticosa

79 - Seed x160

80 - Seed coat surface x2600





## GENERAL DISCUSSION

The Lythraceae sensu stricto, comprising c. 28 genera and 600 species which occur world-wide particularly in the Old and New World tropics and subtropics. In India this family is represented by eight genera and 42 species. The earliest fossil records of the Lythraceae are from the lower Eocene London Clay Flora and the Eocene Deccan Intertrappean beds of India which suggests an Old World, warm temperate origin for the family (Graham & Graham, 1971). The family is now regarded as occupying a key (basal) phylogenetic position within the order Myrtales (Dahlgren & Thorne, 1984; Johnson & Briggs, 1984). Supported by the fossil evidence and inference therefrom, Graham and Graham (1971) has held the opinion that within Lythraceae Lagerstroemia is the most primitive representative. Baas and Zweypfenning (1979) opined that both ray structure and parenchyma distribution or fibre dimorphism of the wood unambiguously point to the advanced level of specialization of the genus Lagerstroemia. They further stated that ray specialization has been very limited in most of the shrubby or herbaceous members, and these have juvenilistic rays composed mainly of erect rays and sometimes completely lacking in axial parenchyma.

The tribal circumscription attributed by Bentham and Hooker (1867), Clarke (1879) and Koehne (1903) are not followed in the present work, because the delimitations set by Bentham and Hooker (1867) and Clarke (1879) are apparently artificial. Koehne (1903) erected the tribes based on complete septal development (Tribe Nesaeae) and incomplete septal development (Tribe Lythrae) which are erroneous according to Graham et al. (1986), who have stated that all genera are characterised by incomplete septal development. Studies conducted on wood anatomy by Baas and Zweypfenning (1979) and palynology by Lee (1974) and Graham et al. (1990) support the interpretation that there is no major natural division in the family corresponding to the tribes recognised by Bentham and Hooker (1867), Clarke (1879) and Koehne (1903).

The genera Rotala, Ammannia and Nesaea form a complex and this has been a matter of confusion among various workers. Bentham and Hooker (1867) divided Ammannia into two sections viz., section 1 - Rotala containing the genus Rotala and section 2 - Euammannia comprising both Ammannia and a part of Nesaea. Clarke (1879) had given subgeneric status to the sections proposed by Bentham and Hooker (1867), while Koehne (1903) proposed a classification of the complex by recognising Rotala, Ammannia and Nesaea as

separate genera based on the nature of dehiscence of the capsule. Details of dehiscence pattern of these genera are already discussed in the taxonomic treatments of the respective genera. Panigrahi (1979) has critically studied using gross morphology, anatomy, pollen and seed morphology of this complex and concluded that the segregation of the genera from the erstwhile genus Ammannia proposed by Koehne (1903) is appropriate, and she has clearly delimited the three genera as distinct. The spermoderm sculpturing pattern studied by using the SEM in the present work also supports the generic delimitation set by Koehne (1903) and Panigrahi (1979) at least for the genera Rotala and Ammannia. According to Graham et al. (1990) the pollen of Rotala (small, 18-24 x 15-20  $\mu\text{m}$ ; 6 faint pseudocolpi; scabrate to finely verrucate to regulate) can be distinguished easily from that of Ammannia (larger, 30-34 x 24-28  $\mu\text{m}$ ; 6 distinct pseudocolpi; striate). The genera Rotala, Ammannia and Nesaea are considered as distinct in the present work.

Rotala is a genus of about 45 species, common in hot or warm parts, aquatic or amphibious, and is best represented in Asia and Africa. Twentyone species are confined to Africa and Madagascar and 20 species in the south and east Asia and Australia. According to Cook (1979) the region of

maximum morphological diversity of the genus is south Asia, and he has commented that it is unusual in one genus to find upto five related annual species growing intermingled. He opined that the reason for the species richness without ecological differentiation is probably correlated with a high degree of inbreeding. However, considering the luxuriance of population of the five species it may be possible that the uniform ecological condition favour the species richness in uniform aquatic environment. The genus includes both annual and perennial species. The perennial species (R. wallichii, R. rotundifolia, R. macrandra) have showy flowers, with distinct inflorescence, and they flower during a distinct season. The annual species (R. mexicana, R. fimbriata, R. densiflora, R. rosea, R. indica) were found to be efficiently self pollinated and had non-showy flowers. Cook (1979) is of the view that the large showy flowered, perennial species are more primitive and have also suggested that the solitary flowers of Rotala may be the one reduced from cymose inflorescence. Panigrahi and Panigrahi (1977), after studying the vascularisation of the flowers/inflorescences in different species of Rotala and Ammannia, have pointed out that the solitary axillary flowers to be primitive and not a reduced structure, at least within the family Lythraceae.



In the present study the genus Rotala, which forms a number of species complexes in India, has been critically studied based on gross morphology and SEM observations of the spermoderm for assessing the species delimitations within the genus. Rotala rosea and R. densiflora are two closely allied species, and they were treated variously by different earlier workers as conspecific or distinct species in their works. However, Koehne (1903) has treated both the species as distinct, while Clarke (1879) and Blatter and Hallberg (1918) have treated them as conspecific. Van Leewan (1977) and Cook (1979) have considered them as distinct species. As per the present observations it is found that R. rosea differs from R. densiflora in characters such as monomorphic leaves with cuneate to obtuse leaf bases; bracteoles as long as calyx tube; petals smaller and caducous; style inconspicuous and exserted capsules. SEM studies of the seed surface in the present work showed that in R. rosea the pattern of spermoderm sculpturing is reticulate, whereas in R. densiflora it is striate. This also appears to support the distinction between R. rosea and R. densiflora. Palynological studies of Graham et al. (1990) revealed that pollen of R. densiflora has four apertures separated by meridional ridges with a pseudocolpus on each side, while R. rosea has three apertures and without any meridional ridges and pseudocolpi. Rotala rotundifolia and

R. macrandra complex, on analysis, showed that the characters of R. macrandra are strong enough to treat it as a distinct species. Rotala indica - R. subrotunda complex have been studied critically. Observations of the holotype of R. subrotunda which is located in this study, and other specimens and also the SEM observation of the spermoderm, have yielded evidences strongly suggestive of the distinctiveness of the two species. This study thus supports the views held by both Koehne (1903) and Cook (1979).

Ammannia L. is a genus of about 25 species of aquatic or marsh-inhabiting herbs distributed in both the temperate and tropical zones. In India, the genus is represented by seven species including the species newly described in the present work. Ammannia baccifera and A. multiflora are rather widely distributed, and found throughout India, while A. desertorum, A. senegalensis and A. nagpurensis are restricted to western India, and A. octandra to south India. Ammannia auriculata is one of the predominant broad leaved weeds in rice fields of northern India are occurring in northwest, central and eastern India also. In gross exomorphic characters, Ammannia auriculata and A. desertorum resemble one another excepting the coarse habit and pappillose indumentum found on the tender parts of the stem,

leaves and calyx of the latter. SEM findings of the spermoderm of the two species have clearly indicated that ample differences are present in the sculpturing pattern of the spermoderm of these two species. Ammannia multiflora is a widely distributed species in India, and shows much continuous variations in its habit and other exomorphic characters. But, certain specimens collected from Nagpur showed very long peduncle (1.0-1.5 cm long) and calyx lobes rounded with mucronate tips. These characters are found to be out of range of variation exhibited by the commonly distributed A. multiflora plants, and are also found to be discontinuous variations. SEM studies of the spermoderm also emphasise the separate identity of A. nagpurensis from A. multiflora. According to Hutchinson and Dalziel (1927), A. senegalensis is very variable species with which A. multiflora and A. auriculata are conspecific, and is not in conformity with their distinctive seed morphological features.

The genus Nesaea consists of approximately 50 species of annual and perennial herbs. The region of its maximum species diversity is Africa. In India the genus is represented by three species, of which Nesaea brevipes is widely distributed, while N. lanceolata is confined to southern India. Nesaea triflora is represented by a single collection from Bengal.

Lythrum is a genus of about 35 species of primarily Eurasian and north American distribution. The genus is represented in India by two species, both of which are confined to northwest Himalayas. Lythrum salicaria is characterised by heterostyly (trimorphic) and panicle type of inflorescence, and is confined to the states of Kashmir and Himachal Pradesh. Lythrum tribracteatum is monomorphic and have axillary solitary flowers occurring in Kashmir Himalayas.

The genus Woodfordia comprises two species which are shrubs of semixerix habitats. Woodfordia uniflora is found in east and west Africa. Woodfordia fruticosa grows in Madagascar and southeast Asia, and it grows throughout India except southern Western Ghats.

Pemphis is a monotypic genus found mainly on the rocky or sandy shores of east Africa and islands throughout the Indian and western Pacific Oceans. The sole species, Pemphis acidula is characterised by solitary, axillary, 6-merous flowers with small, erect calyx lobes and white petals; the capsule dehiscence is circumscissile. The anatomical features of pemphis acidula stands out from all Lythraceae by its non-septate, thick walled fibres and vascicentric xylem parenchyma (Baas & Zweypfenning, 1979).

In India the genus occur in Tamil Nadu, Andaman and Nicobar Islands and Lakshadweep Islands.

Lawsonia is a monotypic genus, probably native to notheast Africa and southwest Asia, but widely cultivated throughout the Old World tropics and subtropics as a source of the red dye henna and as an ornamental plant. Lawsonia inermis is a shrub or small tree with multi-flowered panicles, 4-merous flowers with white petals. The capsule is indehiscent with non-winged pyramidal seeds. Eventhough pollen morphology does not suggest a close relationship between Lawsonia and Lagerstroemia, the wood anatomy and floral morphology place them closest.

The genus Lagerstroemia includes approximately 53 species of small to large trees, distributed from southeast Asia to northern Australia. Lagerstroemia is the only genus of Lythraceae with a centre of speciation <sup>is</sup> southeast Asia. In India the genus is represented by seven species of which three are endemic. Lagerstroemia parviflora and L. speciosa are rather widely distributed. L. indica is well known as a widely planted ornamental and also running wild in the Himalayan regions and Assam forests, while L. microcarpa is an endemic species restricted to the mixed deciduous forests of Western Ghats stretching from Kerala to Gujarat.

L. hypoleuca is endemic to Andaman and Nicobar islands. L. minuticarpa, an endemic and endangered species is confined to northeast India, and L. ovalifolia a well known species of Malaya and Indonesia is also found growing in the Andaman and Nicobar islands.

## SUMMARY

The family Lythraceae sens. str. of India have been studied on the basis of taxonomy and seed morphology. The conclusions are summarised below.

1) The family constitute 8 genera and 42 species indigenous to India. The genera are Ammannia, Lagerstroemia, Lawsonia, Lythrum, Nesaea, Pemphis, Rotala and Woodfordia. Rotala having 20 species is the largest genus followed by Ammannia and Lagerstroemia with seven species each. All genera are studied in detail regarding their taxonomy, distribution, ecology and phenology, uses etc. In India there is no endemic genus for this family, but 11 species are endemic to India. This constitute 26% of the total number of species occurring in India.

2) The following new species, new records, lectotypifications, new synonyms, new distributional records etc., have been presented in this thesis.

(i) New species:

Ammannia nagpurensis Mathew et Nayar

(ii) New records for India:

- a. Rotala rubra (Buch.-Ham. ex D. Don) Hara
- b. Rotala triflora (L.) Kunth
- c. Lythrum tribracteatum Salzern ex Spreng

(iii) Lectotypifications:

- a. Ammannia desertorum Blatter & Hallb.
- b. Ammannia multiflora Roxb.
- c. Nesaea brevipes Koehne
- d. Lagerstroemia minuticarpa Debberm. ex P.C. Kanj.
- e. Rotala floribunda Wight

(iv) New synonyms:

- a. Rotala vasudevanii Joseph & sivar.
- b. Ammannia baccifera L. subsp. aegyptiaca (Willd.)  
Koehne
- c. Ammannia baccifera L. Subsp. viridis (Hornem)  
Koehne

(v) New important distributional records:

- a. Rotala illecebroides Koehne, earlier known only from South India have been recorded from Madhya Pradesh, Northern India.
- b. Rotala macrandra Koehne, previously known only from Kerala State have been recorded from the states of Maharashtra and Goa.
- c. Rotala malampuzhensis R.V. Nair ex C.D.K. Cook found only from Kerala State have been reported from Karnataka and Maharashtra States.



- d. Rotala ritchiei (Clarke) Koehne, an endangered species represented only by two gatherings from Northern Western Ghats have been recorded from Southern Western Ghats as well.
- e. Rotala verticillaris L. found in Southem India and Sri Lanka have been reported from West Bengal.
- f. Extension of distribution to different states have been stated under 'Notes' of each species wherever applicable or under 'distribution'.

3) In this study, seeds of 31 of the 42 native species representing all the eight genera were examined with the Scanning Electron Microscope. Characteristics of the seeds and their surface cells are described and compared. SEM studies of seed coat revealed structural diversities and refined details for systematic application. The pattern of spermoderm sculpturing in different taxa of the family are characteristic and they are more or less specific. Most of the members of the family show reticulate, rugose, lineate, striate, papillose and patterns which fall intermediate or complex of one or more of these basic patterns of spermoderm sculpturing. Flakes or lumps of waxy depositions over the spermoderm were found in some species of the genus Lagerstroemia. The spermoderm sculpturing pattern results coincide with the taxonomic decisions taken in this study.

4) The seeds of the genus Ammannia, in which the seed coat cells are arranged irregularly in a net-work like pattern is considerably different from the pattern exhibited by Rotala, in which the cells are arranged end to end in definite parallel rows in the longitudinal axis of the seed.

5) The spermoderm sculpturing pattern and the seed coat cell structure provided supporting evidences for the delimitation of various species complexes within the genus Rotala such as: Rotala densiflora - Rotala rosea, Rotala macrandra - Rotala rotundifolia, Rotala indica - Rotala subrotunda.

6) Ammannia desertorum, which otherwise appears to have closely related to Ammannia auriculata, stand apart noticeably from it on the basis of seed characteristics. The more or less convex outer tangential walls of the seed coat cell with scattered pits throughout its surface is a unique character of Ammannia auriculata.

## BIBLIOGRAPHY

- ALI, R. 1977. Chromosome number in some species of Lagerstroemia. Curr. Sci. 46: 579-580.
- ALMEIDA, S.M. AND M.R. ALMEIDA. 1989. New records for Maharashtra. J. Bombay Nat. Hist. Soc. 85(3): 521.
- BAAS, P., AND R.C.V.J. ZWEYPFENNING. 1979. Wood anatomy of the Lythraceae. Acta Bot. Neerl. 28: 117-155.
- BAILLON, H. 1877. Fistoire des Plantes. 426-457.
- BARTHLOTT, W. 1981. Epidermal and seed surface characters of plants: systematic applicability and some evolutionary aspects. Nord. J. Bot 1(3): 345-355.
- BENTHAM, G. and J.D. HOOKER. 1867. Genera plantarum 1: 773-785. London.
- BIR, S.S. AND M. SINDHU. 1975. IOPB Chromosome number reports XLIX. Taxon 24: 515.
- BLATTER, E. AND F. HALLBERG. 1918. A revision of the Indian species of Rotala and Ammannia. J. Bombay Nat. Hist. Soc. 25: 707-722 & 26: 210-218.
- BLUME, C.L. 1856. Lythriaceae. In Museum Botanicum Lugduno-Batavum 2(9): 129-137.
- BRIGGS, B.G. AND L.A.S. JOHNSON, 1979. Evolution in the Myrtaceae - evidence from inflorescence structure. Proc. Linn. Soc. New South Wales 102: 157-256.

- BURMAN, J. 1737. Thesaurus Zeylanicus Exhibens Plantas in Insula Zeylans Nascentes, Interquas Plurimae Novae Species et Genera Inveniuntur. Omnia iconibus illustrata et descripta. Amsterdam.
- CLARKE, C.B. 1879. Lythraceae. In Hooker, J.D. Flora of British India 2: 565-581. London.
- COOK, C.D.K. (ED.) 1974. Water plants of the world. Dr. W. Junk, The Hague.
- COOK, C.D.K. 1978. The Hippuris Syndrome. In Street, H.E. (ED.). Essays in plant taxonomy. 163-175.
- COOK, C.D.K. 1979. A revision of the genus Rotala (Lythraceae). Boissiera 29: 1-156.
- COOKE, T. 1901. Flora of the Presidency of Bomaby 1: 506-513.
- CORNER, E.J.H. 1976. The seeds of Dicotyledons, 2 volumes. Cambridge Univ. Press, Cambridge.
- CRONQUIST, A. 1968. The evolution and classification of flowering plants. Houghton Mifflin Co., Boston.
- CRONQUIST, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.

- CUTLER, D.F. 1979. Leaf surface studies in Aloe and Haworthia species (Liliaceae): taxonomic implications. Trop. Subtrop. Pflanzenwelt 28: 449-471.
- CUTLER, D.F. AND P.E. BRANDHAM. 1977. Experimental evidence for the genetic control of leaf surface characters in hybrid Aloineae (Liliaceae), Kew Bull. 32:23-42.
- DAHLGREN, R. 1975. A system of classification of the angiosperms to be used to demonstrate the distribution of characters. Bot. Not. 128: 119-147.
- DAHLGREN, R. 1980. A revised system of classification of the angiosperms. Bot. J. Linn. Soc. 80: 91-124.
- DAHLGREN, R. AND R.F. THORNE. 1984. The order Myrtales, Circumscription, variation and relationships. Ann. Missouri Bot. Gard. 71: 633-699.
- DARWIN, C. 1865. On the sexual relations of the three forms of Lythrum salicaria. J. Linn. Soc. Bot., 8: 169-196.
- DARWIN, C. 1877. The different forms of flowers on plants of the same species. London.
- DE CANDOLLE, A.P. 1828. Prodromus Systematis Naturalis Regni Vegetabilis, 3: 75-95.
- DUTHIE, J.F. 1903. Flora of the Upper Gangetic Plain 1: 348-354.

- ENGLER, A., AND H. PRANTL. 1936. Die naturlichen Pflanzenfamilien Ed. 2, Leipzig.
- FURTADO, C.X. AND M. SRISUKO. 1969. A revision of Lagerstroemia L. Gard. Bull. Singapore 24: 185-334.
- GAMBLE, J.S. 1919. Flora of the presidency of Madras 1(3): 506-514.
- GRAHAM, A. AND S.A. GRAHAM. 1971. The geologic history of the Lythraceae. Brittonia 23: 335-346.
- GRAHAM, A., S.A. GRAHAM, J.W. NOWICKE, V. PATEL AND S. LEE. 1990. Palynology and systematics of the Lythraceae. III. Genera Physocalymma through Woodfordia, Addenda, and conclusions. Amer. J. Bot. 77(2): 159-177.
- GRAHAM, A., J. NOWICKE, J.J. SKVARLA, S.A. GRAHAM, V. PATEL AND S. LEE, 1985. Palynology and systematics of the Lythraceae. I. Introduction and genera Adenaria through Ginoria Amer. J. Bot. 72: 1012-1031.
- GRAHAM, A., J.W. NOWICKE, J.J. SKVARLA, S.A. GRAHAM, V. PATEL AND S. LEE. 1987. Palynology and systematics of the Lythraceae. II. Genera Haitia through Peplis. Amer. J. Bot. 74(6): 829-850.
- GRAHAM, S.A. 1964. The genera of Lythraceae in the Southeastern United States. J. Arn. Arbor. 45: 235-250.

- GRAHAM, S.A. 1985. A revision of Ammannia (Lythraceae) in the Western Hemisphere. J. Arnold Arbor. 66: 395-420.
- GRAHAM, S.A., H. TOBE AND P. BAAS. 1986. Koehneria, a new genus of Lythraceae from Madagascar. Ann. Missouri Bot. Gard. 73: 788-809.
- HAINES, H.H. 1922. The Botany of Bihar and Orissa 1(3): 373-380.
- HARA, H. AND L.H.J. WILLIAMS. 1979. An Enumeration of the Flowering Plants of Nepal 2: 171-173.
- HIERN, W.P. 1871. Lythraceae. In D. Oliver Flora of Tropical Africa 2: 464-481.
- HILAIRE, JAUME ST. 1805. Lythrarieae. Expos. Fam. 2: 175.
- HUTCHINSON, J. 1926. The families of flowering plants. 1. Dicotyledons. Macmillan & Co., London.
- HUTCHINSON, J. 1959. The families of flowering plants. 1. (Ed.2). Dicotyledons. Clarendon Press, London
- HUTCHINSON, J. AND J.M. DALZIEL 1927. Flora West Tropical Africa 1: 142-145.
- IQBAL DAR, M. 1975. Lythraceae. In Nasir, E. & S.I. Ali, Flora West Pakistan No. 78: 1-13.

- JOHNSON, L.A.S. AND B.G. BRIGGS. 1984. Myrtales and Myrtaceae - a phylogenetic analysis. Ann. Missouri Bot. Gard. 71: 700-756.
- JOSEPH, K.T. AND V.V. SIVARAJAN, 1988. Rotala cookii: a new species of Lythraceae from India showing Hippuris Syndrome. Pl. Syst. Evol. 159: 141-144.
- JOSEPH, K.T. AND V.V. SIVARAJAN, 1989. Rotala Linn. (Lythraceae) in peninsular India. Proc. Indian Acad. Sci. (Plant Sci.): 99(3): 179-197.
- JOSHI, A.C. 1939. Embryological evidence for the relationships of the Lythraceae and related families. Curr. Sci. 8: 112-113.
- JOSHI, A.C. AND J. VENKATESWARLU, 1936. Embryological studies in the Lythraceae, III. Proc. Indian Acad. Sci. Sect. B. 3: 377-400.
- JUSSIEU, A.L. DE. 1791. Genera Plantarum secundum ordines Naturales Disposita. Paris.
- KANJILAL, U.N., P.C. KANJILAL AND A. DAS 1938. Flora of Assam 2: 308-316.
- KEAY, R.W.J. 1954. Lythracea. In J. Hutchinson & J.M. Dalziel. Flora West Tropical Africa Ed. 2. 1: 163-166.
- KOEHNE, E. 1880. Lythraceae. 1. Rotala L. In A. Engler, Bot. Jahrb. 1: 142-178 & Lythraceae. II. Ammannia (Houst.) L. Ibid. 240-262.



KOEHNE, E. 1883. Lythraceae monographice describuntur. In A. Engler, Bot. Jahrb. 4: 12-27.

KOEHNE, E. 1903. Lythraceae. In A. Engler (Ed). Das Pflanzenreich Heft 17, IV, 216, 1-326. Weinheim.

KURZ, S. 1877. Forest Flora of British Burma 1: 516-528.

LAMARCK, J.B.A.P.M. de, 1783. Tableau Encyclopedique et Methodique des Trois Regnes de la Nature, 1: 39. Botanique, Paris.

LEE, S. 1979. Studies on the pollen morphology in the Lythraceae. Korean J. Bot. 22: 115-133.

LEE, S. AND L. LAU. 1983. Lythraceae. In Flora Reipublicae Popularis Sinicae 52: 67-111.

LEEUWEN, B.L.J. VAN. 1974. A preliminary revision of the genus Rotala (Lythraceae) in Malesia. Blumea 21: 53-56.

LEWIS, D. 1975. Heteromorphic incompatibility systems under disruptive selection. Proc. Roy. Soc. Lond. B 188: 247-256.

LINNAEUS, C. 1737. Genera Plantarum

LINNAEUS, C. 1753. Species Plantarum

LINNAEUS, C. 1759. Syst. Pl. ed. 10: 1076.

- LINNAEUS, C. 1770. Muenchhausen's Der Hausvater 5: 357.
- LINNAEUS, C. 1771. Mantissa Plantarum Altera Generum. Ed. 6: 143-144, et Specierum. Ed 2: 175.
- MEHRA, P.N. 1976. Cytology of the Himalayan hardwoods.
- MERRILL, E.D. 1912. Flora of manila: 340-343.
- MURLEY, M.R. 1951. Seeds of the cruciferae of north-eastern North America. Amer. Midl. Naturalist 46: 1-81.
- NAYAR, M.P. 1979. The history of the origin of some of the generic names. Bull. Bot. Surv. India 21: 48-54.
- NAYAR, M.P. AND A.R.K. SASTRY. 1987. Red data book of Indian plants I. Calcutta.
- PANIGRAHI, S.G. 1976 (1979). Studies on generic delimitation of the four genera Rotala, Ammannia, Nesaea & Hionanthera (Lythraceae). Bull. Bot. Surv. India 18:178-193.
- PANIGRAHI, S.G. 1979. A contribution to the palynotaxonomy of four herbaceous genera of Lythraceae. Proceedings of the IV International Palynological conference, Lucknow 1:422-431.
- PANIGRAHI, S.G. 1980. Contribution of anatomy to the systematic of Ammannia. Phytomorphology 30(4): 320-330.

- PANIGRAHI, S.G. 1986. Seed morphology of Rotala L., Ammannia L., Nesaea Kunth and Hionanthera Fernandes & Diniz (Lythraceae). Bot. J. Linn. Soc. 93: 389-403.
- PANIGRAHI, S.G. 1988. Contribution of anatomy to the systematics of Rotala L.(Lythraceae). Bull. Eot. Surv. India 30 (1-4): 90-100.
- PANIGRAHI, S.G. AND G. PANIGRAHI 1977. Evolutionary trends in the inflorescences of the family Lythraceae. In Frontiers of plant sciences - Prof. P. Parija, Felicitation Volume. 401-410.
- PARMER, P.J. 1987. In B.V. Shetty & V. Singh (Eds.) Flora of Rajasthan 324.
- PATEL, V., J.J. SKVARLA AND P.H. RAVEN. 1984. Pollen characters in relation to the delimitation of myrtales. Ann. Missouri Bot. Gard. 71: 858-969.
- PRAIN, D. 1903. Bengal Plants 1:500-504.
- PURI, G.S. 1943. The occurrence of Woodfordia fruticosa (Linn.) S. Kurz in the Karea deposits of Kashmir, with remarks on changes of altitude and climate during the Pleistocene. J. Indian Bot. Soc. 22: 125-132.
- RHEEDE TOT DRAKESTEIN, H.A.VAN. 1678-1703. Hortus Indicus malabaricus, continens regni malabarci apud Indos celeberrimi Omnis generis plantas Rariores, Latinis, Malabaricis, Arabicis et Bramanum characteribus Expressas. 12 Vols. Amsterdam.

- RIDLEY, H.N. 1922. Flora of the Malay Peninsula I: 819-824.
- ROXBURGH, W. 1795. Plants of the Coast of Coromandel I
- ROXBURGH, W. 1820. In W. Carey (Ed.), Flora Indica: or Descriptions of Indian plants 1: 446-449.
- RUMPHIUS, G.E. 1741-50. Herbarium Amboinense, Plusimas Compectens Abrores, Frutices, Herbes, Plantas Terrestres et Adjacentibus Reperiunter Insulis, 6 Vols. Amsterdam.
- SANNI, B. 1943. Indian silicified plants II. Enigmocarpon parijai, a silicified fruit from the Deccan, with a review of the fossil history of the Lythraceae. Proc. Indian Acad. Sci. Sect. B. 17(3): 59.96.
- SARKAR, A.K., N. DATTA AND U. CHATTERJEE. 1980. IOPB Chromosome number reports LXVII. Taxon 29: 361.
- SARKAR, A.K., N. DATTA, U. CHATTERJEE AND D. HAZRA. 1982. IOPB Chromosome number reports LXXVI. Taxon 31: 578.
- SHARMA, A.K. 1970. Annual report, 1967-1968. Res. Bull. Univ. Calcutta (Cytogenetics Lab.) 2: 1-50.
- SHETLER, S.G. AND N.R. MORIN 1986. Seed morphology in North American Campanulaceae. Ann. Missouri Bot. Gard. 73(4): 653-688.

- SHOME, U., S.MEHROTRA AND H.P. SHARMA. 1981. Pharmacognostic studies on the flower of Woodfordia fruticosa Kurz. Proc. Indian Acad. Sci. **90**: 335-351.
- SHUKLA, V.B. 1944. On Sahnianthus, a new genus of petrified flowers from the Intertrappean Beds at Mohgaon kalan in the Deccan and its relation with the fruit Enigmocarpon Parijai Sahni from the same locality. Proc. Nat. Acad. Sci. India **14**: 1-39.
- TAKHTAJAN, A. 1966. Systema et Phylogeniae Magnoliophytorum. Soviet sciences press, Moscow & Leningrad.
- TAKHTAJAN, A. 1969. Flowering plants: Origin and Dispersal Olivar & Boyd, Edinburgh.
- TAKHTAJAN, A. 1980. Outline of classification of flowering plants (Magnoliophyta). Bot. Rev. **46**:225-359.
- TAKHTAJAN, A. 1986. Floristic regions of the world. University of California Press, Berkeley.
- TOBE, H., P.H. RAVEN AND S.A. GRAHAM. 1986. Chromosome counts for some Lythraceae sens. Str. (Myrtales), and the base number of the family. Taxon **35**: 13-20.
- TRIMEN, H. 1893. A Handbook to the Flora of Ceylon **2**: 222-232.
- VASUDEVAN NAIR, R. 1965. New record for Hydrolythrum wallichii Hook. f. in South India. J. Bombay Nat. Hist. Soc. **61**: 718-719.

- VASUDEVAN NAIR, R. 1969. A new record for Ammannia auriculata Willd. (A. senegalensis Lamk.) from South India. Bull. Bot. Surv. India 10:238.
- WIGHT, R. 1837. Contributions to India Botany. Nimmoia R.W. Madras J. Lit. Sci. 5: 311-313.
- WIGHT, R. 1840. Illustrations of Indian Botany 1: 204-207. Madras.
- WIGHT, R. 1840-1853. Icones Plantarum Indiae Orientalis, or figures of Indian Plants. 6 Vols. Madras.
- WIGHT, R. AND G.A.W. ARNOTT. 1834. Prodromus Florae Peninsulae Indiae Orientalis 1(2): 302-307.
- WEBB, D.A. 1968. Lythraceae. In Flora Europaea. 2: 300-303.

## APPENDIX I

## ABBREVIATIONS OF VERNACULAR NAMES

1. Assamese	Assam.
2. Bengali	Beng.
3. Gujarati	Guj.
4. Hindi	Hind.
5. Kannada	Kan.
6. Malayalam	Mal.
7. Marathi	Mar.
8. Oriya	Or.
9. Punjabi	Punj.
10. Rajasthani	Raj.
11. Sanskrit	Sans.
12. Tamil	Tam.
13. Telugu	Tel.

**APPENDIX II**

**REPRINTS OF PUBLICATIONS**



**STATUS :** Rare; known to occur only in two localities in the north-eastern India. It was first collected from Kerempani in Assam by U. N. Kanjilal in 1913 and subsequently from Singtam in Sikkim by Ribu & Rhomoo. It was again recollected from Kerempani, Assam, by P. C. Kanjilal in 1931 and was last collected from Kerim Forest, Assam, by Deka in 1938.

**DISTRIBUTION :** Endemic to Assam and Sikkim.

**HABITAT AND ECOLOGY :** This species was collected from the subtropical forest of Assam at 100 - 120 m alt. and from hills of Sikkim 1200 - 1500 m alt.

**CONSERVATION MEASURES TAKEN :** No conservation measure has been taken to protect the species in its habitats so far.

**CONSERVATION MEASURES PROPOSED :** Efforts should be made to locate them in the type locality to raise plants from seeds for introducing in botanic gardens.

**BIOLOGY AND POTENTIAL VALUE :** Use and potential value of this species are not known. But in the case of other species of *Lagerstroemia* the timber is useful and some are grown for their beautiful flowers. This flowers during August-October; fruits throughout the cold season.

**CULTIVATION :** This species is not known so far in cultivation.

**DESCRIPTION :** A tree, up to 35 m tall; stem very irregularly fluted; bark greenish white, exfoliating in large thin papery sheets of scrolls. Leaves opposite, 6 - 12 × 3 - 5 cm, elliptic or oblong, acuminate at apex, sub-rounded at base, sub-coriaceous, glabrous above, midrib and veins pubescent beneath, petiolate. Panicles terminal, 7 - 10 cm long, densely pubescent. Calyx tube broadly campanulate, ca 6 mm long, pubescent, 12-ribbed; lobes 6, triangular, acuminate, upper half pubescent within. Petals 6, ca 2.5 mm long, oblong, crumpled. Stamens numerous, 6 stouter and longer than the rest. Ovary subglobose, 6-loculed; style long, exserted; stigma capitate. Capsule ca 5 × 3 mm, ellipsoid, 3 - 6-valved. Seeds ca 5 mm long, winged.

**REFERENCES :**

1. Furtado, C. X. & Srisuko, M. (1969). *Gard. Bull. Singapore* 24 : 287.
2. Kanjilal, P. C. (1934). *Assam For. Rec. Bot.* 1 : 9.
3. Kanjilal, U. N. *et al.* (1938). *Fl. Assam* 2 : 311.

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**ROOTALA RUBRA (BUCH.-HAM. EX D. DON) HARA-  
A NEW RECORD FOR INDIA**

**P. Thomas Mathew**

*Botanical Survey of India, Howrah - 3.*

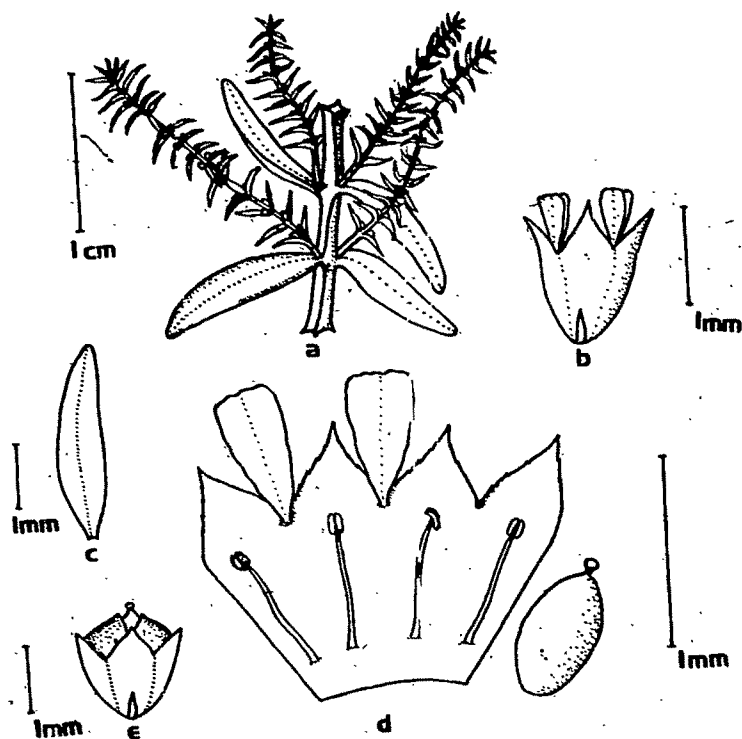
During the revisionary studies of the family Lythraceae the author came across a specimen collected from Siliguri, W. Bengal deposited in Central National Herbarium (CAL), which on critical examination turned out to be *Rotala rubra* (Buch.-Ham. ex D. Don) Hara, a species hitherto known only from Nepal. This particular specimen (intermingled with *R. rosea* (Poiret) C.D.K. Cook) was earlier misidentified as *Ammannia pentandra* Roxb. This record therefore shows its extension of distribution to India. A detailed description with an illustration is provided here.

*Rotala rubra* (Buch.-Ham. ex D. Don) Hara, J. Jap. Bot. 52(7): 197. 1977; C.D.K. Cook in Boissiera 29: 96. 1979.

*Ammannia rubra* Buch.-Ham. ex D. Don, Prodr. Fl. Nepal. 220. 1825; Wall. cat. no. 2107. 1929. *Ammannia pentandra* Roxb. sensu C.B. Clarke in Fl. Brit. Ind. 2: 568. 1879, p.p.; *Rotala alata* Koehne in Bot. Jahrb. I: 171. 1880 et in Engl. Pflanzenr. 17 (IV. 216): 40, f. 4F. 1903.

*Type* : Napaul (Nepal), *Hamilton* s.n. (BM).

Annual erect herbs. *Stems* ca. 15 cm long, highly branched; branches opposite, longer than subtending leaves; stem and branches 4 winged, wings whitish, discontinuous. *Leaves* decussate, ca. 12 × 2.5 mm, ovate-oblong or oblong, cuneate at base, obtuse at apex. *Flowers* sessile, solitary in axils of bracts; bracts leaf like, small; bracteoles 2, inconspicuous, ca. 0.3 mm long. *Calyx* tubular, tube campanulate, ca. 1 mm long; lobes 4, long acuminate, ca. 0.5 mm long, margin toothed. *Petals* 4,



a. Habit (two nodes enlarged), b. Flower, c. bract, d. Flower dissection, e. dehiscent capsule.

inserted at the top of the calyx tube, obovate, equaling or slightly exceeding the calyx lobes, *ca.* 0.75 mm long, margin undulate, apex truncate. *Stamens* 4, *ca.* 0.75 mm long, adnate near the base of the calyx tube. *Ovary* subglobose, *ca.* 1 mm long, 0.5 mm across; style short *ca.* 0.1 mm long; stigma capitate. *Capsule* subglobose, *ca.* 1 mm across, 3 valved, exceeding the calyx lobes. *Seeds* small, suborbicular.

*Distribution* : India : West Bengal; Nepal.

*Specimens examined* : India : Siliguri, W. Bengal, Nov. 1878. S.L. s.n., Acc. No. 175889 (CAL); Nepal : s. loc. Wallich 2107 (Type of *Rotala alata*, CAL).

#### Acknowledgements

The author is grateful to Dr. M.P. Nayar, Director, Botanical Survey of India for guidance and facilities.

## THE GENUS *LYTHRUM* L. (LYTHRACEAE) IN INDIA

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### ABSTRACT

The genus *Lythrum* L. which is represented by 2 species in India is revised. *L. tribracteatum* is reported here as a new record for India. Detailed descriptions with synonyms, distribution and illustrations are also given.

### INTRODUCTION

The genus *Lythrum* L. comprises ca. 35 species primarily distributed in Eurasia and North America. In India the genus is represented by 2 species both of which occur only in the N.W. Himalaya.

Koehne (1881) mentioned Kashmir in his distributional data for *Lythrum salicaria* L. and this consequently became the first record of the genus from India. Oddly enough this species was not included in the *Flora of British India* even though some collections dating back as early as 1864 are available. This omission was observed by H. Collett who in a letter (dated 12 Oct. 1886) to G. King remarked, "I cannot conceive why *L. salicaria*, the purple loose-strife of England has not found a place in the FBI. I found in this morning growing abundantly and undoubtedly wild for 3 or 4 miles in the marshy ground which borders the left bank of the Beas river...". Subsequently, Stewart (1972) reported it from Pakistan and Kashmir.

Until now the genus *Lythrum* was believed to be represented in India by only 1 species. While revising the Indian Lythraceae the author came across an interesting collection of *Lythrum tribracteatum* from Baramula in Kashmir. There is no earlier record of this species in India. Therefore, *L. tribracteatum* is reported here from India for the first time.

### LYTHRUM

*Lythrum* L., Sp. Pl. 446. 1753; Gen. Pl. ed. 5. 205. 1754; Willd. Sp. Pl. 2. 866. 1799; Poir. in Lamk. Encycl. 6 : 451. 1804; DC., Prod. 3 : 80. 1828; Boiss., Fl. Or. 738. 1872; Koehne, Bot. Jahrb. 1 : 305. 1881 & in Engl. Pflanzenr. 17 (4. 216) : 58. 1903; Webb in Tutin *et al.* Fl. Europaea 2 : 300. 1968; Chamberlain in Devis, Fl. Turkey 4 : 174. 1972; M. I. Dar, Fl. Pakistan No. 78 : 7. 1975; Murav'eva in Fl. USSR 15 : 402. 1986 (Repr. ed.); *Salicaria* (Tourn.) Adans, Fam. 2. 1763; Tourn ex Mill., Gard. Dict. ed. 4 1752. *Bergenia* Neck., Elem. Bot. 2 : 108. 1780,

Mathew

*Mozula* Raf., in Journ. Phys. 6. 1819.  
Lectotype species : *L. salicaria* L.

Annual or perennial herbs or subshrubs of moist habitats, glabrescent to tomentose. Leaves membranous, decussate, alternate or often verticillate, ovate to linear, sessile or subsessile, attenuate to cordate at base. Flowers regular, (4-) 6-merous, sometime heteromorphic with 2 or 3 floral forms, axillary 1 or 2 at a node or in terminal spikes or racemes, sessile or shortly pedicellate. Bracteoles 2, linear, opposite. Calyx tube cylindrical, greenish, 4-8 mm long, 8-12 nerved, lobes (4-) 6, triangular, acute to acuminate at apex; appendages as many as calyx lobes alternating with them, narrowly triangular, shorter than to exceeding the calyx lobes. Petals (4-) 6, inserted at the top of calyx tube, rose-purple or white, caducous. Stamens 4-12, in 1 or 2 whorls, inserted deep in the calyx tube; anthers included to exserted; filaments in heteromorphic forms of 2 or 3 lengths. Ovary sessile, or stipitate, ellipsoidal or subcylindrical, 2-locular, style simple, thin, included or exserted, in heteromorphic forms of 2 or 3 lengths; stigma capitate. Capsule membranous, ellipsoidal or cylindrical, dehiscing by 2-valves. Seds many, small, triangular, obovate.

*Distribution* : Europe, Asia, Africa, N. America, Australia.

#### Key to the species

- 1a. Flowers monomorphic, solitary in axils of floral leaves; stamens 4-6, all included 2. *L. tribracteatum*
- 1b. Flowers trimorphic, forming spicate

inflorescence; stamens 12, some or all exserted 1. *L. salicaria*

1. *Lythrum salicaria* L. Sp. Pl. 446. 1753; Boiss., Fl. Or. 2 : 738. 1872; Koehne, Bot. Jahrb, 1 : 326. 1881 & in Engl., Pflanzenr. 17 (4. 216) : 73. 1903; Kitamura in Fl. Afghanistan 277. 1960; Webb. in Fl. Europaea 2 : 301. 1968; Chamberlain in Davis, Fl. Turkey 4 : 175. 1972; Stewart, Annot. Cat. Vasc. Pl. Pak. & Kashmir 500. 1972; M.I. Dar in Fl. Pakistan No. 78 : 7. 1975; Chowdhery & Wadhwa, Fl. Himachal Pradesh 1 : 290. 1984; Polunin & Stainton, Flow. Himal. 147. 1984; Murav'eva in Fl. USSR 15 : 411. 1986 (Repr. ed.) *L. tomentosum* Mill, Gard. Dict. ed. 8(2) : 1768; DC. Catal. Hort. Monsp. 123. 1813. *L. salicaria* L. var. *tomentosum* (Mill.) DC., Prod. 3 : 83. 1828; Koehne, Bot. Jahrb. 1 : 329. 1881. *L. intermedium* Ledeb., Ind. Sem. Hort. Dorpat. Mose. 92. 1838; Murav'eva in Fl. USSR 15 : 413. 1986. *L. cashmerianum*, Royle, Ill. Bot. Himal. 203. 1839.

*Type* : Described from Europe (Linn, Savage Cat. No. 626/1).

Perennial herbs or subshrubs. Stem 30-150 cm long, simple or branched, ribbed, glabrous to tomentose, woody. Leaves sessile, upper alternate, lower opposite, 3-7 x 0.5-2 cm, ovate to linear-lanceolate, cordate or rounded at base, acuminate at apex, puberulous on both sides or only on midribs and veins beneath to tomentose on both sides or rarely glabrous. Spikes 10-65 cm long, terminal, simple or branched. Flowers



Fig. 1 *Lythrum salicaria* L.

clustered in axils of bracts; pedicel 1-2 mm long; bracts 5-40 x 2-3 mm, ovate to linear-

lanceolate, base cordate, acuminate at apex; bracteoles 2, linear, equalling to or half as long as calyx tube, margins ciliate. Calyx tube cylindrical or tubular-campanulate, 5-7 x 2-3 mm, 12-ribbed, glabrous or tomentose, sometimes ribs hairy, lobes 6, 0.75-1 mm long, triangular, acuminate at apex, margins ciliate; appendages 6, 1.5-2 mm long, subulate, ciliate at apex or rarely fully. Petals 6, 6-9 x 2-4 mm, oblong or obovate-lanceolate obtuse at apex, cuneate at base, inserted at the top of calyx tube, purple. Stamens 12, dimorphic; filaments of episealous stamens long and exserted, c. 7 mm; filaments of epipetalous stamens, short and included, c. 3.5 mm; anthers dimorphic, those of long stamens 0.5 x 0.4 mm and those on short stamens 0.3 x 0.25 mm. Ovary c. 2.5 x 1 mm ellipsoid, bilocular; style simple, of different lengths, in short-styled flowers up to 1 mm long, in medium-styled flowers up to 5 mm long and in long-styled flowers up to 8 mm long; stigma capitate. Capsule c. 3-4 x 2 mm, ovoid or ellipsoidal, 2-valved, included in the calyx tube. Seeds many, obovate.

**Distribution :** Europe, USSR, Iran, Turkey, Afganistan, Pakistan, India. Japan, China, Korea, Tibet, N. America, N. Africa and Australia.

**Ecology:** In India it occurs on river banks, lake shores and other marshy places of Himalaya up to 1800 m altitude.

**Fls. & frs. :** July-September.

**Specimen examined :** India : KASHMIR Falconer 454 (CAL); Gammie s.n., 1891 (CAL, DD); Thomson s.n. (CAL); T.A. Rao 844 (CAL); Koebel 70 (CAL); Keshavanand

Thomas Mathew

1382 (DD); *Lambert* 192 (DD); *Inayat* 25615 (DD). HIMACHAL PRADESH : *Brandis* 3206 (CAL, DD); *Collet* s.n. (CAL); *Watt* 13448 (CAL, BSIS); *Bor* s.n. (DD); *Parker* 3361 (DD).

*Lythrum tribacteatum* Salzm. ex Spreng., Syst. Veg. 4(2) : 190. 1827; Koehne, Bot. Jahrb. 1 : 312. 1881 & in Engl. Pflanzenr.

17 (4. 216) : 64. 1903 excl. var. *candolei* Koehne; Kitamura in Fl. Afghanistan 278.1960; Webb in Fl. Europaea 2 : 301. 1968; Chamberlain in Davis, Fl. Turkey 4 : 177. 1972; Murav'eva in Fl. USSR 15 : 411. 1986 (Repr. ed.). *L. bibracteatum* Salzm. ex DC., Prodr. 3 : 81. 1828; Boiss., Fl. Or. 2 : 740. 1872.

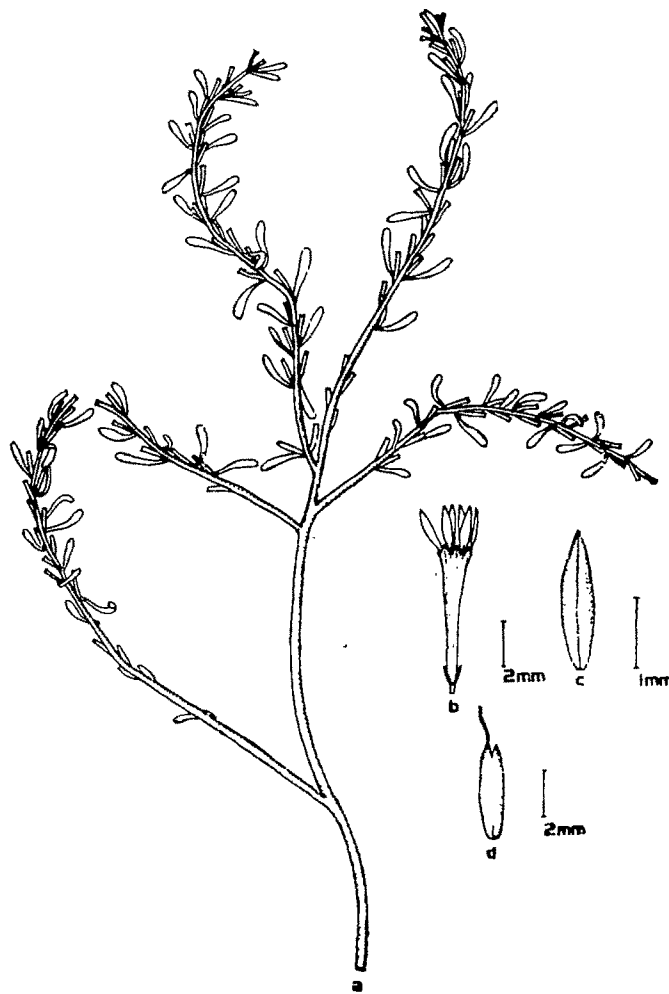


Fig. 2. *Lythrum tribacteatum* Salzm. ex Spreng.

*Type* : Described from France. Ager Monspelensis 1827 Salzmann (K ?).

Glabrous erect, herbs, c. 25 cm long. Stem branched, terete below, 4-angled above; angles scabrous. Leaves simple, sessile, alternate, 6-12 x 1-2 mm, linear, rarely oblanceolate, attenuate at base, obtuse at apex, margin and midribs scabrous beneath. Flowers solitary, axillary, short pedicelled: pedicel c. 0.5 mm long; bracteoles 2, c. 0.5 mm long, linear, eciliate. Calyx c. 5.5 x 0.5-1 mm, narrowly cylindrical, 12-nerved, lobes 6, c. 0.5 mm long, triangular; appendages 6, narrower, as long as lobes. Petals 6, c. 2 x 0.5 mm, oblong, attenuate at apex. Stamens 4-6, inserted in the calyx tube at different levels; filaments of the lower stamens c. 2 mm long, filaments of the upper stamens c. 1 mm long. Ovary 3-3.5 x 0.25-0.3 mm; cylindrical; style 2-2.5 mm long; stigma capitate. Capsule c. 4 x 1 mm, narrowly cylindrical, included in calyx-tube. Seeds, c. 0.5 mm, triangular, numerous.

*Distribution* : Europe, USSR, Iran, Turkey, Afganistan, and India (Kashmir).

*Notes* : This is the first record of this species from India. The plant was collected from Baramula in N. W. Himalaya at 1200 m altitude by A. Meebold (1905). He identified it as *L. tribracteatum* and mentioned in the herbarium as "new for India."

*Specimen examined* : India : Kashmir, Baramula, Sept. 1905, Meebold 4620 (CAL).

#### ACKNOWLEDGEMENTS

The author is grateful to Dr. M.P. Nayar, Director, Botanical Survey of India for guidance and facilities.

#### REFERENCES

- KOEHNE, A. 1881. *Lythrum* L. in Engl.. *Bot. Jahrb.* 1 : 305-332.
- STEWART, R.R. 1979. An annotated catalogue of the vascular plants of West Pakistan & Kashmir 500.



A NEW SPECIES OF *AMMANNIA* L. (LYTHRACEAE) FROM INDIA

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A NEW SPECIES OF *AMMANNIA* L. (LYTHRACEAE) FROM INDIA

***Ammannia nagpurensis*** T. Mathew *et* Nayar,  
*sp. nov.* (Fig. 1).

Affinis *A. multiflorae* Roxb. sed caulibus parce ramosis, pedunculis longioribus (ad 15 mm longis), calicis lobis subrotundatis, apicem mucronatis, floribus fructibusque laxibus, antheris plano insertionis petalorum acquis differt.

*Typus* : India, Maharashtra, Nagpur Dt., Jalankeri farm, 283 m, 20.11.1957, *Subramanyam* 4717 (Holo : CAL ; Iso : MH).

Annual, glabrous herbs. *Stems* up to 30 cm long, erect, sparsely branched, usually with one or two basal branches, four-winged. *Leaves* simple, opposite decussate, 3-15 × 0.5-3.0 mm, linear-oblong with auriculate-cordate base, acute at apex, entire, glabrous, membranous, semi-amplexicaulous. *Flowers* in

axillary simple or compound pedunculate cymes ; peduncles filiform ; primary peduncles 8-15 mm long ; secondary peduncles up to 7 mm long ; (1-)3-7(-15) flowers per cyme ; pedicel 1.5-2 mm long ; bracteoles 2, at the base of pedicel. *Calyx tube* campanulate, ca 1 mm long, lobes 4, subrotundate, mucronate. *Petals* 4, 0.5-1 mm long, obovate, inserted at the rim of calyx tube, pink, caducous. *Stamens* 4, inserted on the middle of calyx tube, filaments 0.5-0.6 mm long, anthers borne level with the base of petals. *Ovary* 0.75-1 mm long, globose, wall membranous, 2-loculed, many ovules in each locule ; style distinct, 0.75-1 mm long, persistent in fruits ; stigma capitate. *Capsules* up to 2 mm across, globose, exserted, opening irregularly. *Seeds* many, minute, 0.35 × 0.25 mm, ovoid, brown.

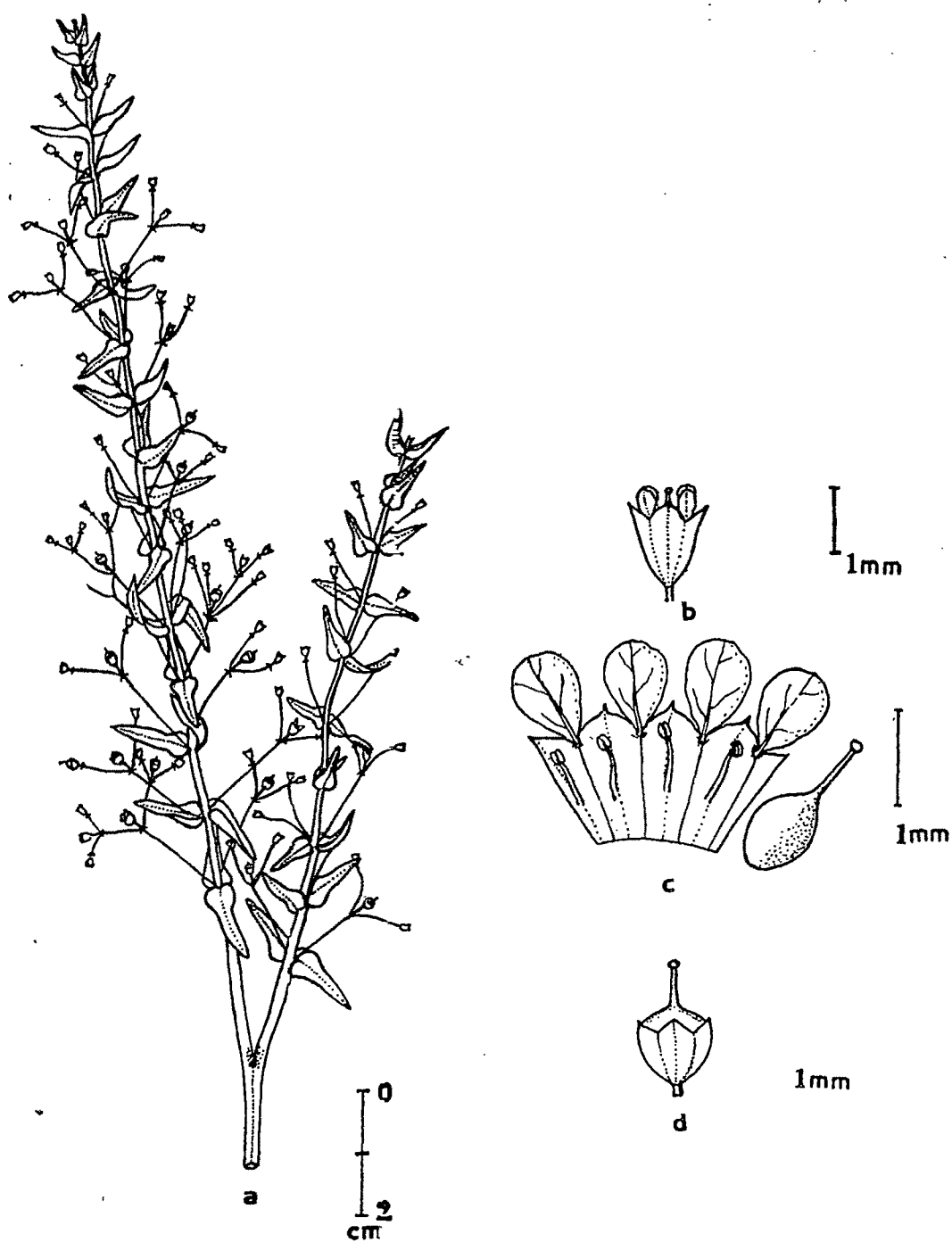


Fig. 1: *Ammannia nagpurensis* T. Mathew et Nayar  
a. Habit. b. Flower. c. Flower split opened. d. Capsule.

*Seed morphology (SEM Studies) :**Ammannia nagpurensis* (Plate 1a & b) *A. multiflora* (Plate 1c & d)1. Size :  $0.35 \times 0.25$  mm.

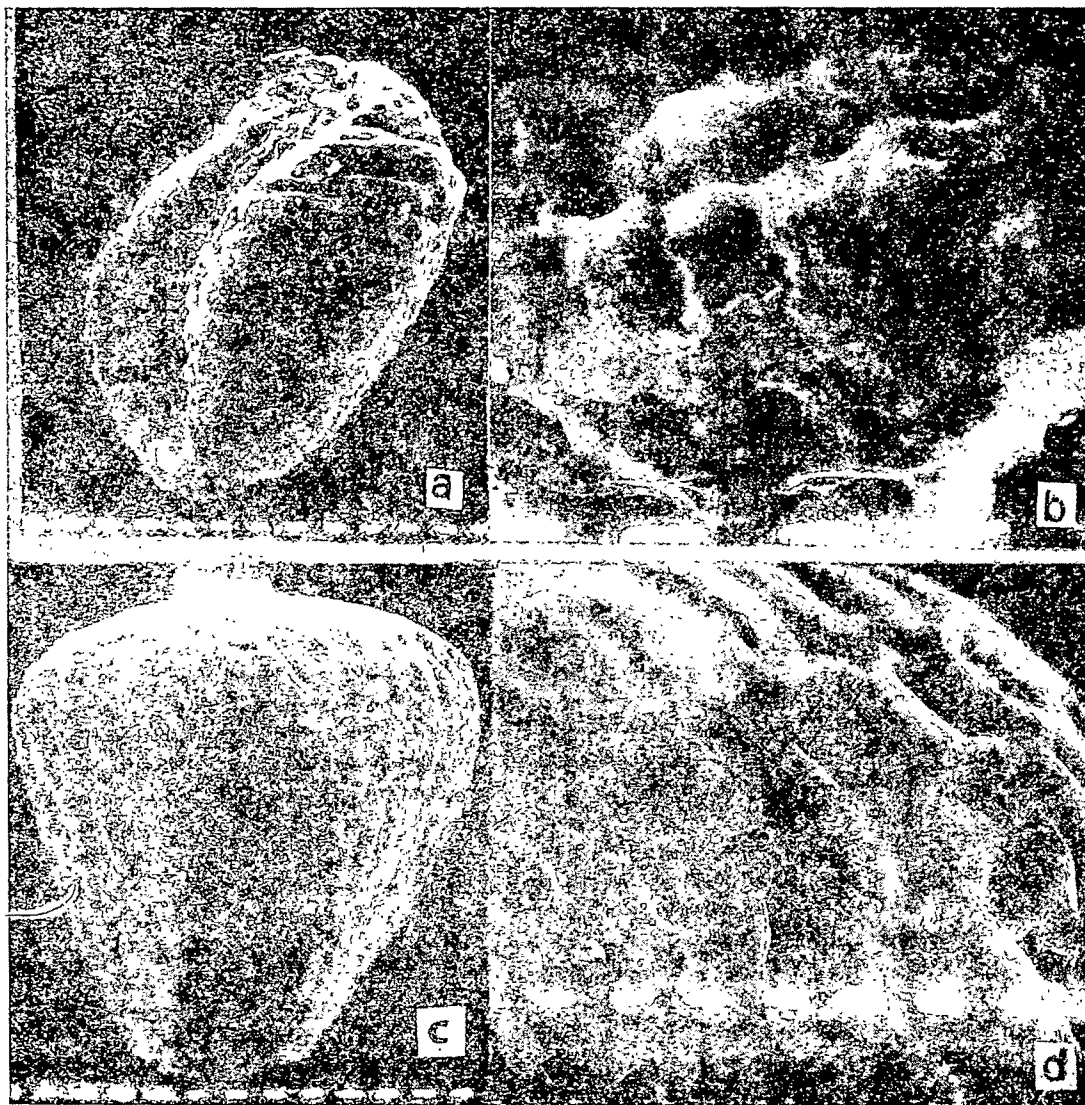
2. Shape : Ovoid.

3. Surface : Spermoderm cells quadrangular. Boundary walls of spermoderm cells unevenly thickened and without any pores.

 $0.45 \times 0.3$  mm.

Triangular-ovoid.

Spermoderm cells rectangular. Boundary walls of spermoderm cells uniformly thickened with scattered pores throughout.

*Fls. & Frts.* : October-November.*Distrib.* : INDIA : Maharashtra, Gujarat.*Ecology* : Growing in paddy-fields, river-banks and other moist places.*Specimens examined* : INDIA : Maharashtra, Nagpur Dt., Starky point, 7.11.1946,

Scanning electron micrographs of seed coat.

Plate 1: Figs. a-d. a—b. *A. nagpurensis* (Subramanyam 4717): a. Dry seed showing dorso-ventral surfaces  $\times 320$ . b. Part of dorsal surface showing quadrangular spermoderm cells  $\times 1250$ . c—d. *A. multiflora* (Thomson s.n.): c. Dry seed showing dorsal surface  $\times 320$ . d. Part of dorsal surface showing rectangular spermoderm cells  $\times 640$ .

*Mirashi* 252 (BLAT). GUJARAT : Dangs, Unai, Westward along Rly. line, 3.11.1953, *Santapau* 17268 (BLAT); Saurashtra, Sasan-gir to Junvania, 5.10.1953, *Santapau* 16359 (BLAT).

*Notes* : *A. nagpurensis* T. Mathew et Nayar is closely allied to *A. multiflora* Roxb. but can easily be distinguished from it by having : sparsely branched stem, very long peduncles (up to 15 mm), subrotund calyx lobes with mucronate tip, stamens as long as or shorter than the calyx tube and flowers and fruits lax, whereas in the latter species stem densely branched, peduncles shorter (up to 5 mm), calyx lobes triangular with acute or acuminate apex, stamens longer than the calyx tube and flowers and fruits

crowded. Spermoderm of both the species have been studied under the Scanning Electron Microscope (SEM) and observed that the shape, orientation as well as thickenings of the cells are different from each other.

This species is named after its type locality.

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A NOTE ON THE DISTRIBUTION OF *ROTALA RITCHIEI* (CLARKE) KOEHNE

In course of the revisionary studies of Lythraceae, the authors came across an interesting herbarium specimen, which on critical examination turned out to be *Rotala ritchiei* (Clarke) Koehne, a very rare plant that was hitherto known to be strictly endemic to the northern W. Ghats as it was known only from two isolated collections from Belgaum and Pune. This particular specimen (Fischer 1419, CAL), collected from Devarakerai at ca 1575 m altitude in the Coimbatore hills of Tamil Nadu State, was earlier misidentified as *Ammannia pentandra* Roxb. The correct identification of this specimen thus extends the distribution of *R. ritchiei* to the southern W. Ghats as well. Apparently at one time the species had a much wider range in the W. Ghats. The species, *R. ritchiei*, is based on Ritchie's collection from the "rice fields ..... amongst floating weeds" in Belgaum and was originally described as *Ammannia ritchiei* Clarke.

After a lapse of nearly a hundred years

since the type collection, it was recollected in the year 1966 (Janardhanan, 1979). The locality from which it was then collected is now completely disturbed owing to urbanisation and no populations of *R. ritchiei* could be located there later on. This threatened species is already listed in the Indian Plant Red Data Book (1987).

The plant is an annual, half-submerged, aquatic herb with a very short life span. It appears soon after monsoon in the submergible areas at the shallow fringes of ponds and starts flowering from August onwards. The specialised habitat of the plant is obviously the reason why it escapes notice and, as such, has such a poor representation in herbaria. An intensive survey of the Devarakerai and similar habitats in the adjoining areas is warranted to see if any surviving populations of this very interesting plant can be found. Since the species is at present feared to be vulnerable, every attempt should be made to locate this species in its

known range and study its biology for conservation purposes. Since wetland ecosystems are getting depleted, it is necessary to identify areas of its distribution.

*Specimens examined* : INDIA : Tamil Nadu, Coimbatore Dt., Devarakerai, 5200 ft. 13 Feb. 1907, *C. E. C. Fischer* 1419 (CAL); Maharashtra, Poona Dt., Kochala cha talao, on Chakan-Alandi Road, 16 Aug. 1966, *Janardhanan* 68579 (BSI); *ibid* 8 Oct. 1966, *Janardhanan* 92784 (BSI); Karnataka, Belgaum, Oct. *Ritchie* 1184 (TYPE, PHOTO-CAL).

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#### REFERENCES

- JANARDHANAN, K. P. Rediscovery of *Rotala ritchei* (C. B. Clarke) Koehne (Lythraceae) after one hundred years. *Bull. Bot. Surv. India* 21 (1-4) : 230. 1979.  
— In : NAYAR, M. P. & A. R. K. SASTRY, (Ed). *Red Data Book of Indian Plants* 1 : 190-191. 1987.